Post-Mortem Technique

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THE TECHNIQUE OF POST-MORTEM EXAMINATION

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BY

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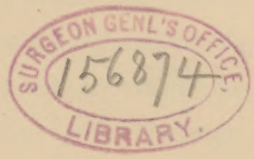
WITH FORTY-ONE ILLUSTRATIONS



CHICAGO
THE W. T. KEENER COMPANY
1894

PREFACE.

In the following pages the subject of post-mortem examination has been considered with especial reference to the technique.

The systematic and minute consideration of the various appearances and the diagnosis of pathologic changes in the fresh organs has been purposely avoided, and only such general and comprehensive statements have been made in this direction as were necessary to emphasize the value of the various practical details.

The little book has been prepared particularly for the guidance of the medical students who frequent the demonstrations in pathologic anatomy given by the author at the Cook County Hospital in Chicago; it is also thought that the total absence in this country of statutory regulations to guide and direct the practitioner in medico-legal cases will serve to extend its usefulness, especially as the subject will be considered somewhat more in detail than is the case in the comprehensive text-books of pathologic anatomy and medical jurisprudence.

Among the various writings dealing with this subject that have been consulted, particular reference should be made to those of the following authors: Virchow, Orth, Nauwerck, Delafield and Prudden, Blackburn and D. J. Hamilton.

My thanks are due for aid and advice in various ways to Dr. Louis J. Mitchell, Dr. Weller Van Hook, Dr. A. Gehrman, Dr. Adolph Meyer and Mr. Gayton A. Douglas.

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Accuracy of observation, completeness of detail, and sound conclusions can be obtained only when the post-mortem examination is made according to some definite and systematic plan so that regions and organs are successively examined without disturbing the relations and appearances of structures yet to be investigated.

In order to insure the improved results which such a mode of procedure brings, many European governments prescribe in statutory rules and regulations the exact order to be followed in all medico-legal investigations. In this country such matters are left in the hands of the individual physician without a word of instruction. Consequently the course of justice is more likely to meet with serious obstacles in blundering and defective examinations after death, and medical literature contains many examples of unnecessarily imperfect and incomplete autopsies that leave important pathologic questions undecided and encourage false conclusions.

The wanton waste of valuable pathologic material in many hospitals and public institutions at the present time, on account of defective examination and imperfect record-keeping, reflects seriously upon the scientific interests and spirit of the attending medical and surgical staffs.

THE ROOM, THE TABLE, GENERAL CONVENIENCES, ETC.

In the post-mortem room of the hospital there is usually provided a revolving, concave table through which fluids drain easily (Fig. 1). There is abund-

Fig. 1. Revolving Post-Mortem Table the upper surface of which is concave with a number of central perforations through which fluids drain directly into the sewer.

ant and unobstructed daylight; hot and cold water are within ready reach; suitable sinks must be present: sponges, cloths, aprons, soap, basins, disinfectants and

plates are all in their place; in order to support the head and neck, suitable rectangular wooden blocks with semi-circular excavations are at hand.

Pure, unobstructed daylight is required for correct color interpretation; a post-mortem examination completed in artificial light may not be absolutely trustworthy in its results, particularly as regards the parenchymatous organs, and a final resort should always be had to the microscope.

In a private house the available room with the best light and the least furniture should be selected in which to hold the autopsy. The body can be placed on a firm kitchen table or left lying on the undertaker's stretcher; the floor around the body must be protected by means of oil-cloth or old quilts. Abundant provision for cleanliness in the shape of wash-basins with warm and cold water must be made; towels and sponges should be handy. Bloody hands stain all objects handled, and a corpse with its surroundings spattered and smeared with blood and other fluids does not tend to prepossess the laity in favor of autopsies. One basin should be set aside for washing the hands and instruments in only, which should be done frequently. Blood and inflammatory exudate dried on the fingers is not only unpleasant, but dulls the sensitiveness of the skin. As often as a drop of blood or other fluid falls upon the body it should be sponged off and one should not wipe his knives on the skin of the cadaver. In the hospital post-mortem room water can be allowed to run over the body at frequent intervals, provided care is exercised that its liberal use

does not in any way obscure the condition of the cavities and their contents. Water, when poured freely over a recent, clean, cut surface does not permit one to form any idea as to the original dryness or moisture of the tissue; on the other hand blood and other fluids are nicely removed by dipping the organ in a basin of clean water or directing a small stream over the surface. The knives should be scrupulously clean when the organs are incised and all knives and scissors should be sharp. Smooth and instructive cut surfaces cannot be made with a dull and nicked knife blade: vessels and canals cannot be incised readily and neatly with a dull pair of scissors.

On beginning a post-mortem examination the instruments required should be placed in order upon a tray or board and each instrument, when not in use, should be rinsed in water and returned to its proper place.

THE TIME AFTER DEATH FOR THE AUTOPSY.

At the present time the positive unqualified statement that the sooner after death the autopsy the better, can safely be made. Decomposition, even though slight, makes the finer histologic and much bacteriologic examination useless. Nuclear figures disappear almost immediately after death as the body cools, and this is also true of the vascular endothelium: the delicate lining of mucous membranes desquamates and as time passes secondary post-mortem microbic invasion of the tissues and of the blood may have taken place to such an extent as to seriously interfere

with the establishment of reliable results from the bacteriologic examination, and as decomposition advances, even the gross changes are greatly altered and become correspondingly difficult of detection and correct interpretation. When rigor mortis is fully developed the distribution of the blood throughout the body at the time of death becomes somewhat changed, and observations in regard to the condition of the different portions of the vascular system with reference to the amount of blood contained in them diminish in value. The practice observed in many public hospitals and institutions of delaying, for various inadequate reasons, the autopsy a certain number of hours after death, in some instances as long as two days or more, is consequently often directly destructive of valuable pathologic material, and it should be abolished for the valid reasons above indicated. On the other hand it is almost unnecessary to state that no degree of decomposition should be allowed to deter from the exhaustive thoroughness of the medico-legal examination.

EMBALMED AND FROZEN BODIES.

Should the body have been embalmed before the autopsy, then great care must be exercised in the interpretation of the appearances observed in the tissues, because the fluid usually employed is capable of greatly changing the consistence and the color of the structures with which it comes in contact. If the fluid has been injected into the arterial system through any of the large arteries at one of the most superficial points in

their course, then the changes in the blood vessels and in the heart are very extensive and preclude the recognition, with the naked eye at any rate, of the nicer changes that might be present. The lungs are usually also greatly altered, the parenchyma presenting a rough shrivelled appearance, as though extensive coagulation had occurred; usually a certain part of the total blood mass is removed at the same time as the injection is made, so that after such time it is not possible to form any correct idea as to the blood distribution throughout the organs. Frequently only "cavity embalming" has been done: in this case a long coarse trocar has been passed into the abdomen and attempts made to puncture the intestines in as many places as possible, and then penetrations are made in the direction of the heart, large blood vessels and lungs; subsequently large quantities of strong fluid are pumped into the abdomen through the canula.

In addition to the actual change in the appearance of the tissues that come in contact with the embalming fluid, the numerous punctures may do serious damage in opening abcess and other cavities and allowing fluid accumulations and collections of various kinds to become distributed throughout the large sacs. Occasionally a certain quantity of embalming fluid is forced into the mouth, and small portions may find their way down into the lungs and produce very anomalous and perplexing appearances, and it might not be altogether impossible for some of the fluid to gravitate into the stomach to the annoyance and mystification of the toxicologist. The embalming fluid most frequently em-

ployed contains among other things arsenic and corrosive sublimate in large quantities, and the proclivity of undertakers to promiscuous embalming is notorious. The almost universal absence in nearly all the States of specific and strict statutory instructions bearing upon this dangerous, useless and at present unrestrained practice is certainly a matter of serious concern that ought to receive immediate and prompt attention on the part of the authorities.

If the body to be examined be frozen, arrangements must be made for thawing it out thoroughly before any examination for any purpose whatsoever is attempted, for the obvious reasons that many organs, as for instance the brain, cannot be removed if frozen without fatal damage, and also because the consistence of various tissues and the absence or presence of thrombosis as well as many other important details cannot be determined in structures partly or completely frozen.

The German regulations for the guidance of medical jurists in conducting post-mortem examinations for legal purposes, paragraph 7, say: "*Frozen bodies.*—If the body is frozen, it is to be brought into a warm room, and the examination is not to be proceeded with until the parts are sufficiently thawed. The employment of warm water, or other warm substances for expediting the thawing is not allowable."

THE RECORD.

It is one of the most essential features of a trustworthy post-mortem examination to carefully and accurately record the observations at the time they

are made. It is by cultivating the habit of exact description of thoroughly studied appearances that results of permanent value are reached. The post-mortem records of hospitals and other institutions constitute, when properly kept, available sources of scientific information of importance and value. Consequently an assistant or two are always necessary, if for no other purpose, in order that full and reliable notes may be taken during the progress of the examination. The presence of critical observers stimulates to care and deliberation; medical men should always be invited to be present. It is a good law which requires that two physicians must jointly make the medico-legal section; in Illinois and many other states the individual physician is singly entrusted with the most difficult case. In important medico-legal cases it will be found very advantageous to have a full stenographic record made on the spot; such a report embodying an accurate and complete description of all the organs and structures in the body greatly enhances the value of the autopsy. The record should be made in the same order as the examination; for this reason, each part or step in the autopsy should be completed, if possible, before the next is commenced. If the examination be made according to some generally established routine, then the record will assume order and method. In the report should be described as accurately as possible what is actually observed; the description should be concise, clear, unembellished: it must not include deductions or opinions, the appearances are not to be interpreted at the same time as they are described; they are to be de-

scribed in all necessary detail, not labelled except under the head of diagnosis. The proper post-mortem record should describe the morbid changes and states so clearly and so thoroughly that a correct interpretation or diagnosis can readily be made by any competent man after reading the worded description. The record should embody the following subdivisions:

I. *Preliminary data*, including name, sex, age, color, time of death, time of examination, place of examination, and, in medico-legal cases, the names of the persons present and especially the names of those by whom the body is identified. The temperature of the weather and of the room should be noted where the question of decomposition is to be considered. In medico-legal cases the matter of proper identification of the body must be carefully attended to. The body should be positively identified in the presence of the examiner by some one who knew the dead individual during life, and the names should be written down then and there. If positive identification cannot be obtained, then a full, detailed description of the personal characteristics of the dead body must be taken, and, if possible, the face should be photographed and attached to the record.

II. *Summary of the Clinical History.* This should always be incorporated in the routine record of the autopsy. Clinical information should be gathered from the medical attendant, the friends, the police, or the hospital records, as the case may be, and noted down, so that the post-mortem examination may be made as intelligently as this knowledge can make it practicable.

In hospitals the ward history or a summary thereof must accompany the patient to the dead-house.

III. *The exterior of the body.* Here is included a note as to the size, the development, the nutrition, the rigor mortis, post-mortem lividity, evidences of decomposition and an accurate description of the external lesions or abnormalities of various kinds that may be found. In medico-legal examinations the accuracy of the external description is of great importance. All marks of violence must be carefully described with great minuteness of detail as to location, with reference to fixed anatomic landmarks; as to size and shape, which must be described with mathematic precision: as to the color, the condition of wound margins and the surrounding skin. The condition of the various orifices must also be noted in connection with the inspection of the body. If the body is that of an unknown person observations in regard to the following facts are to be recorded for the purpose of possible future identification, to-wit: color, age, sex, height, weight, build, forehead, face, eyes, nose, hair, teeth, beard, mustache, complexion, scars, marks, condition of fingers and toes, overcoat, coat, vest, pantaloons, underwear, shawl, cloak, dress, boots, shoes, stockings, necktie, shirt, hat, cap, personal property, probable occupation and reason why, etc., as well as a note of the locality where found.

IV. *Internal Examination.* The record should contain a detailed account of the condition and the appearance of the organs, the tissues, and the cavities of the body. It embodies a systematic chronicle of the ob-

servations, as regards the following in connection with the solid organs: The weight, the size as determined by actual measurement, the consistence, the condition of the external surface and the edges as regards unusual roughness and irregularity or change of contour; the degree of union between the capsule or covering membrane and the surface of the organ; the cut surface — its color, smoothness, the amount of blood, the amount and character of other fluid, the condition of the surface markings as observed in the liver and the kidney, the vessels, the odor, the character of the surface scrapings, and lastly the results of the chemical or microscopic examination, or if these be not undertaken at once, the disposition of the tissues for this purpose should be noted down. In regard to the cavities of the body notes are to be made as regards the contents, — the quantity, the color, the consistence, the odor, the reaction, the sediment; then the lining membranes must be described with reference to color, smoothness, lustre, abnormal adhesions, deposits and so forth. The hollow viscera are described as regards contents, the condition of the surfaces, the size and such other points as may be prominent in the individual case. Should the contents of the digestive tract require chemical examination, then a full note is to be made in regard to their preliminary treatment for this purpose. The description of the colors should be exact, specifying in each instance the particular variety observed. The size of the organs, or of abnormal areas or growths should be determined by means of actual measurement; to say that an object is as large as a pigeon's egg, a

millet seed or a walnut, is not as exact as to give the precise dimensions. In these general suggestions pointed directions as to the method of describing extensive or marked morbid changes or growths cannot well be formulated; in a general way it may be said that the various points to be considered in the description of the solid organs apply here also.

V. *The Diagnosis.* Under this subdivision of the record are to be enumerated in the most natural order the various anatomic changes observed and described during the autopsy. Usually the order of importance as regards the cause of death is selected. The anatomic diagnosis represents the opinion of the pathologist with reference to the nature of the lesions observed and this is the only part of the record where, as a general rule, opinions ought to be written down. Only the morbid changes are to be summarized in the diagnosis.

Such a record as here indicated should be made at every post-mortem examination. In many hospitals printed outline forms are furnished upon which the reports are written down. Such forms are useful as a general guide to the beginner and the non-expert physician, by referring to which omissions are less likely to occur. The principal objection to such forms, which undoubtedly are time saving, lies in the fact that they cannot be so arranged as to allow sufficient individuality of description in the proper places of the special findings. With reference to that particular variety of medico-legal cases known as coroner's cases, it may be said that in this country the cause of death is determ-

ined by a jury of laymen; consequently the kind of statement wanted from the physician who makes the autopsy is one that clearly and concisely describes the nature and the cause of death. The statement to the coroner's jury should be worded so that a fairly intelligent layman can readily grasp its meaning and it should not include the many and otherwise important details which must be found in the complete post-mortem report. The examination in such cases must be exhaustively thorough and a full, detailed record should be made during its progress for future reference, as, for instance, during the criminal trial; but the statement to the coroner's jury need only be a comprehensive, clear summary of the findings sufficient to show that the conclusion as to the cause of death is fully warranted.

SAMPLE OF REPORT OF POST-MORTEM EXAMINATION TO THE CORONER.[1]

At an inquest upon the body of John Smith, held July 2nd, 1893, at the Cook County Morgue, City of Chicago, County of Cook, State of Illinois, personally appeared * * * * * * * who being sworn according to law, deposes and says: My name is * * * * * * * ; I reside at * * * * * * * , and am by occupation a physician and surgeon.

I made a post-mortem examination at the Cook County Morgue, July 2nd, 1893, upon the body of a man who was identified in my presence as *John Smith*,

[1] Made on blank furnished for that purpose.

of 200 Fay street, Chicago, by his neighbors, *Thomas Brown* and *Henry Wilson.*

Inspection. The body was that of a well nourished, muscular man, about 30 years of age; it was 5 feet and 11 inches long, and the estimated weight was 185 pounds. The post-mortem rigidity was strong and there were no signs of decomposition.

The following marks of external violence were observed: In the space between the 2nd and 3rd ribs, just to the left of the breast bone was a wound, one inch in length, with smooth, sharp margins, running parallel with the ribs. There was a similar wound over the centre of the upper part of the breast bone. The direction of this wound was oblique from above down to the right, and it was only one-half an inch long. Some blood had flowed down from both these wounds and dried upon the skin, but more from the lower than from the upper.

Internal Examination. The wound between the 2nd and 3rd ribs to the left of the breast bone passed through the pericardium or sac about the heart, and penetrated through the wall of the heart itself; the sac about the heart was consequently filled with fluid and clotted blood which compressed the heart. The wound in the heart was one-half inch long, showing the instrument to have been somewhat pointed; the margins were smooth cut.

The wound over the upper part of the breast bone only extended through the skin, and did not touch the bone. The brain, the lungs, the liver and kidneys, as well as the other organs, were quite healthy. The

stomach contained a quantity of but slightly digested food, in which potatoes in the shape of solid pieces, tomatoes, meat and corn could be recognized.

Conclusion. John Smith died from hæmorrhage following a stab wound of the heart.

Signed.

EARLY STEPS IN THE PREPARATION OF POST-MORTEM MATERIAL FOR MICROSCOPIC AND BACTERIOLOGIC PURPOSES.

It is not proposed to discuss in detail all the various modern micro-technical methods, but to merely mention such preliminary and general procedures as are not too complicated to be employed at any ordinary post-mortem examination.

In order to emphasize the absolute necessity of resorting to microscopic examination during autopsies, it will be amply sufficient to state that Virchow enumerates the following changes as capable of diagnosis only with the aid of the microscope, and certainly the paramount importance of recognizing these alterations can not be disputed:

1. The diffuse fat metamorphosis of the cells in the interstitial tissue of the brain, the spinal cord, the retina and the nerves.
2. The parenchymatous fatty changes in the muscles, the heart, the kidneys, the liver, and the peptic cells of the stomach.
3. Fragmentation of the fibres of the myocardium.
4. Gangliform swelling of nerve fibres.
5. Calcification of the ganglion cells.

6. Fat embolism in the lungs and the kidneys.

7. The white hepatization and the red induration of the lungs.

8. Initial proliferation on part of tissue elements in general.

9. Slightly advanced amyloid degeneration.

The microscopic study of fresh tissues simply requires that small fragments be nicely teased apart in a one-half per cent. salt solution, mounted and inspected in the same; semifluid substances are also best examined microscopically in this solution. For the purpose of staining the nuclei in fresh tissues prepared in this way, Carnoy's solution[1] is very valuable; the specimens can be teased or immersed in this mixture for two or three minutes, then the color is washed away, and the specimens mounted in the salt solution; very instructive mounts from the myocardium, for instance, may be made in this way. Thin sections of fresh tissue are readily made with the aid of some one of the various forms of the freezing microtome or with Valentine's double knife; for further directions as to the use of the freezing microtome see the standard textbooks on microscopic technique.

The mahogany brown color reaction of amyloid degeneration with Lugol's solution (iodine 4.0, potassium iodide 6.0, distilled water 100.0) is obtained by dropping the solution on the cut surface of the suspected organ and allowing it to remain for thirty seconds

[1] Saturated aqueous solution of methyl green to which is added one per cent. of acetic acid and one-tenth per cent. of osmic acid (Delafield and Prudden).

or so; in order to insure an acid reaction in the tissue it is safest, under all circumstances, to first drop a little acetic acid on the cut surface. The iodine solution is washed off with water before looking for areas showing the reaction. By applying the solution to small, thin pieces of tissue in a watch glass or on a slide, and subsequently washing in water, the reaction can be brought out more strikingly, the tissue in general being straw yellow, the amyloid areas brownish-red, in color.

The general practitioner as well as the pathologist should go to every examination fully prepared to place such pieces as may be selected from the various organs into suitable hardening and fixing solutions immediately after their removal from the body. The sooner after death the tissues are fixed the better can the details be studied. To carry pieces from the organs about in paper is uncleanly and liable to damage the tissues. There should, consequently, be a number of small, wide-mouthed bottles at hand, containing the various fluids about to be mentioned, securely corked and with proper labels affixed. As soon as the pieces are dropped in the fluid — not more than two should be placed in each bottle and these should be readily distinguishable tissues, such as lung and kidney, for instance — the label should be filled out. The pieces should be small; as a general rule not over half a centimeter square; in the case of organs provided with a capsule or membrane the pieces from the surface should include the undisturbed external covering; they should be cut with a sharp knife and handled delicately without compression; the pieces should be dropped at

once into the solution selected and they should not be first washed in water. Portions of mucous membranes selected for microscopic purposes should be treated with the greatest delicacy of touch in order not to destroy any more of the surface epithelium than can be avoided. In the case of membranous organs small pieces may be pinned with the mucosa or internal membrane upward on flat, thin slices of cork and then placed singly in a bottle of the hardening and fixing solution. The label should show the history of each piece in the bottles: The name or number of the body examined, the date of the autopsy, the length of time after death, the organ and the district in this from which the piece is taken and any other information necessary (Fig. 2).

Fig. 2.—Bottle with Muller's fluid containing pieces from the kidney and lung.

1. *Alcohol.* Absolute alcohol fixes and hardens many tissues quite satisfactorily. Tissues that are to be examined for bacteria are usually placed in absolute alcohol. There are a number of tissues, however, in

which alcohol produces such changes as contraindicate its use. Alcohol dissolves the fatty substances, especially in the nervous as well as many other tissues, which on this account are not placed in this fluid. Alcohol also dissolves the red blood corpuscles and when circulatory processes are to be studied the tissue should be fixed in fluids that preserve the blood cells.

The ease with which alcohol is obtained and its almost universal adaptability as a hardening agent when only the more general and topographic features are considered need not, however, even in the country, force the physician to rely solely upon spirit.

2. *Müller's fluid.*[1]

Potassium bichromate.....	2½ parts.
Sodium sulphate.....	1 part.
Distilled water. By weight 100	parts.

This is a cheap, easily and universally obtainable, valuable solution; it is used most extensively for the nervous system, but it can be and is employed with equal advantage foral most every soft tissue in the body. There are numerous modifications of this solution, but for general purposes the formula given will answer very well. This solution fixes and preserves the substances extracted and dissolved by alcohol, namely the blood corpuscles and the fat. The pieces should be small and the quantity of fluid quite large and at first the solution must be changed often, every day. Müller's fluid will harden quite large pieces, even whole organs, such as the brain and spinal cord, when care is

[1] Of late a 2 to 2·5% aqueous solution of bichromate of potassium has replaced Müller's fluid to quite an extent; either one may be used.

used to change the fluid often. For the further treatment of tissues placed in Müller's fluid reference is made to the text-books on microscopic technique. At the present time it is sufficient to insist upon the placing of small pieces of tissue and even whole organs in this fluid immediately upon their removal from the body and without washing in water, the fluid to be changed daily.

3. *Flemming's solution.*

A. 1% aqueous solution chromic acid..11 parts.
Glacial acetic acid ..... 1 part.
Distilled water ..... 4 parts.

B. 2% solution of osmic acid in 1% aqueous chromic acid solution.[1]

For use, mix 4 parts of A and 1 part of B. By mixing the two solutions when necessary there is no danger of deterioration and in this way the cost of Flemming's solution is much diminished.

[1] "The osmic acid may be obtained from the chemical houses, and comes in sealed glass tubes containing either $\frac{1}{2}$ or 1 gram of the crystals. In making the solution B, the following precautions are to be observed: The glass-stoppered bottle in which the mixture is to be kept is thoroughly washed with water, then rinsed with sulphuric acid, and finally rinsed with distilled water. The requisite quantity of one per cent. chromic acid is now made in the cleaned bottle, using distilled water and pure chromic acid for this purpose. If we had one gram of osmic acid we would require 50 c.c. of the chromic solution. The tube containing the osmic crystals is now to be freed of the label, thoroughly washed in water, scratched with a file, and dropped into the bottle of chromic acid solution. By means of a clean glass rod the tube is now broken, the bottle stoppered and set aside."—(Ohlmacher, *North American Practitioner*, February, 1892.)

When the tissues are obtained absolutely fresh, *i.e.*, immediately after death, they should be subjected to real and precise fixation with Flemming's solution in order that the finer, ultimate details of the cellular structure can be studied. The pieces should not be any larger than 4*mm.* square and enough solution should be poured on to cover the specimens. After twenty-four hours they are washed with running water for two hours or immersed in frequently changed, quiet water for six hours: then dehydration in alcohol of gradually increasing strength is commenced: 50% alcohol 2 to 6 hours, 70% 6 to 12 hours, then 95% alcohol for 24 hours, or indefinitely.

4. *Saturated Aqueous Solution of corrosive sublimate.* 1: 14. Small pieces may be fixed in this for one-half to two hours, washed in running water for twelve hours, and gradually hardened and dehydrated in alcohols of increasing strength, and preserved in 95 per cent. This solution can be extemporaneously prepared with the surgeon's bichloride tablets and it fixes quite well but not as perfectly as the chromo-osmo-acetic acid mixture.

Summary. In order to obtain valuable tissues for the various microscopic purposes post-mortem material should be judiciously fixed and hardened according to the nature of the tissue and the case.

Every effort should be made to obtain the tissue as fresh as possible.

Alcohol, Müller's fluid, Flemming's solution or a saturated aqueous bichloride solution should be at hand in suitable bottles.

Perfectly fresh tissues should be fixed as directed in Flemming's mixture, or in its absence in the bichloride solution; such tissues can subsequently be stained for bacteria and karyokinesis.

Absolute alcohol is to be used when the tissues are removed some time after death, and are to be examined bacteriologically.

Müller's fluid is always to be used for hardening the brain and the spinal cord: almost any tissue can be hardened in this fluid and subsequently studied with very good advantage as regards the ordinary pathohistologic changes.

Tissues fixed in Flemming's or in the bichloride solution can be transported to laboratories while still in the fixing solution, if the distance allow it; otherwise they can be sent after they have reached the 95 per cent. alcohol. Tissues in alcohol or in Müller's fluid can be sent as they are.

Structures lined or covered with epithelium, such as the ovaries, the uterus, the intestines, the ependyma of the encephalic cavities etc., should be handled as little as in any way possible so that the delicate cells are not needlessly rubbed off.

Opportunities to make cultures and smear preparations during a post-mortem examination should not be neglected even though the more elaborate appliances for carrying on bacteriologic investigation are not within immediate reach. Smear preparations can be made from abscess contents, fluid accumulations, exudates as in pericarditis or pleuritis, the blood, endocardial vegetations, the cut surface of solid organs, etc.: a

minute quantity of blood or of fluid is placed upon the thin glass cover, or the cover-glass is brought in direct contact with the freshly cut surface of such organs as the liver or lung, or a little moisture or solid material is carried from the cut surface to the cover-glass with an aseptic metal spade or a forceps. The material thus brought upon the glass should be distributed over the surface as evenly and as thinly as possible; two glasses may be pressed together and then separated by sliding them apart; this will usually leave a thin layer on the surface of each slip, or the material may be spread out evenly and thinly by drawing the end of a smooth-edged glass slide over the face of the cover slip near the edge of which has been placed a small drop. Sternberg prefers to spread the material on a slide instead of on a slip, because the latter is easily broken or lost during the subsequent manipulations. The even, thin layer upon the surface of the absolutely clean and dry cover-slip or slide is now allowed to dry in the air, and then the preparations are passed three times through the flame of an alcohol lamp, the smeared surface upward, in order to coagulate the albumen and make the material adhere to the glass. If the glass slide is used this can be held with the fingers; the cover slip smears, on the other hand, are held in small forceps. When from blood it may be best to fix the smear preparation in equal parts of absolute alcohol and ether.

During the foregoing manipulations all precautions against accidental contamination must be rigidly observed; the cavities or tissues must be incised with sterilized knives, and the material at once transferred to

the glass which has been cleansed in alcohol and thoroughly dried; all knives, forceps and spades used for this purpose are readily sterilized in an alcohol lamp flame.

Smear preparations of this kind will keep for a long time and may be forwarded to the laboratories by placing the slides in the common slide boxes while unmounted cover-glasses may be gummed to cardboard on the side opposite to the film; the cardboard can now be packed in tin or wooden boxes so that the covers are free from contact.

The value of the results obtained by staining and studying smears is, of course, not as great as desirable except in the case of such microbes as have a differential stain, like the bacillus of tuberculosis. In the majority of instances culture media must be inoculated and the characteristics of the microbes in the growing colonies observed before definite bacteriologic diagnosis can be established.

Test tubes with the usual solid culture media can be brought to the post-mortem examination and inoculated during its progress, when the distance from the laboratory is not too great. Stab cultures of this kind are made with a sterilized platinum needle which transfers minute bits of tissue or fractional drops of fluid into the medium in the tube through the centre of which they are plunged; the tube is usually held inverted with the left hand, the cotton plug is removed and held by its very top between the fingers of the same hand, while the needle is carefully introduced through the centre of the tube without touching its

sides; if the upper surface of the medium is slanting, then a scratch may be made along the oblique aspect. Immediately after the stab or the scratch the plug is reintroduced and the surface outside the tube singed in the flame.

Organs and cavities from which material is planted in this way are incised with newly sterilized knives or scissors, and in addition the cut surface is again sterilized before the needle is forced into the tissue below.

Tubes inoculated in this manner can be transported for some distance provided the temperature is not such as to stop the growth of certain sensitive bacteria like the *Micrococcus lanceolatus*. For the purpose of transportation the following precautions must be observed: Cultures on 8–10 per cent. gelatine should have the upper ends of the tubes closed by fusing the glass, as they may melt and run into the plugs. Upon arrival the end may be cut off and a cotton plug inserted in the tube.

Agar agar and 15 per cent. gelatine may be sent without danger of melting. However, as there is often some expressed fluid in tubes a double cotton plug is sometimes advisable; this is a small sterilized cotton plug below the one in the end of the tube and is inserted to catch any fluid present.

Tubes should be packed in strong wooden boxes with enough cotton to absorb all the fluid present in case of breakage. Tubes in quantity should be sent by express as they receive more care. The top of the box should be plainly marked "*This side up.*"

In case it should be concluded to send fluid or solid material, then sterilized tubes and glass stoppered bottles must be provided; such tubes and bottles should be carried in a strong sterilized paper box, hermetically sealed with oil paper, and not opened until everything is ready for use. The tissues and fluids are conveyed to the tubes by means of sterile spades and other instruments, and immediately thereafter the upper ends are closed by fusing the glass. The wide-mouthed, glass-stoppered bottles should be covered with tin foil in order to keep out the dust.

When specimens are to be kept cold the tubes or bottles may be wrapped in cotton and cloth and placed in a larger jar filled with a strong salt brine and ice.

All bottles and tubes should be packed in sufficient cotton to absorb all the fluid present. Smaller specimens may be sent by mail,[1] but should then be in strong metal cases or in the official mailing cases.

POST-MORTEM DISSECTION WOUNDS.[2]

The ordinary forms of wound infection, simple suppuration, cellulitis, lymphangitis, regional lymphadenitis, erysipeloid, erysipelas, etc., are not what we most dread in making post-mortem examinations. It is the development of sudden violent septicemia which is most appalling, although the first mentioned forms are by no means trivial.

Individual failure of immunity plays a powerful part in the causation of these diseases. But, as Welch

[1]By a recent decision from the Post Office Department material of this kind that is considered infectious is excluded from the mails.

[2]Prepared at author's request by Dr. Weller Van Hook, Chicago.

has justly said, in those severer forms of infection which destroy in a few hours the lives of healthy men who have inoculated themselves through trivial wounds, it is the quality of the infectious material which brings about the fatal result, and not any especial predisposition on the part of the individual.

The ideal treatment of post-mortem wounds would be the immediate disinfection of the injured tissues in all cases with the same care as would be given if it were absolutely certain that such a virulent poison were always present. This treatment might be formulated as follows:

(1.) Instantaneous interruption of venous and lymphatic circulation by any convenient constricting band.

(2.) Careful disinfection of the skin about the injured part by scrubbing with a strong antiseptic solution (one per mille corrosive sublimate or five per cent. carbolic acid).

(3.) Exposure of all parts of the wound, if necessary by incision with a sterilized instrument. The escape of blood and lymph should be encouraged.

(4.) Application of a strong antiseptic solution (ninety-five per cent. solution carbolic acid) to all parts of the wound.

(5.) Removal of constricting band and application of a wet antiseptic dressing.

But as it is only very rarely that these violent infections occur, and as most of the pathologists prefer

to "take their chances" without resorting to this elaborate treatment, the following rules may be suggested as being less radical:

(1.) Never begin a post-mortem examination until all cuts upon the exposed skin have been either cauterized to destroy the absorptive power or securely covered with impermeable material (such as rubber gloves, finger cots, or antiseptic cotton fastened down by a solution of caoutchouc in chloroform[1]).

(2.) In the event of a wound occuring during the examination, grasp the injured member above the point of injury and, if possible, force a few drops of blood out of the wound.

(3.) Scrub the region of injury with a good antiseptic solution.

(4.) Clip away the epidermis, if necessary to expose the wound.

(5.) Cauterize the wound (if an ordinary puncture or small incision) with ninety-five per cent. carbolic acid worked well into the bottom of the wound.

(6.) During the remainder of the autopsy wear an impervious dressing over the wound, unless some one can step in and finish the work.

(7.) After the examination apply upon the wound a wet antiseptic dressing.

(8.) Never seal up a dissecting wound with collodion or caoutchouc solution.

(9.) After receiving such a wound be on your guard for evidence of infection, in order to treat it promptly.

[1]Collodion does not furnish a waterproof dressing.]

STATISTICAL.

The following statistical material (principally from Vierodt's *Daten und Tabellen*, Jena, 1893) is introduced for the sake of convenience of reference:

Average Weight and Dimensions of Healthy Adult Organs.

	WEIGHT.	DIMENSIONS.
Adrenals	4.8—7.29	4.5×2.8×0.5 cm.
Brain	m. 1358 g w. 1235 g	15—17—14×12.5 cm.
Heart	m. 300 g w. 250 g	

Length 8.9 cm., width 8.5—10 cm., thickness 3—3.6 cm.	
Circumference at base of ventricles	25.8 cm.
Thickness of left ventricular wall	1—1.4 cm.
Thickness of right ventricular wall	0.3—0.5 cm.
Depth of left ventricle	9.5 cm.
Depth of right ventricle	10.0 cm.
Circumference of mitral orifice	10.4—10.9 cm.
Circumference of tricuspid orifice	12.—12.7 cm.
Circumference of aortic orifice	7.7—8.0 cm.
Circumference of pulmonary orifice	8.9—9.2 cm.
Kidneys, (conjoint w'ght) 299 g.	11—12×5—6×3—4.5 cm.
	Cortex thickn's 0.4—0.6 cm.
	Relation of cortex to medulla 1:3
Lungs	r. 513 gr l. 441 gr
Liver	1610 g
	Length from right to left 25—32 cm.
	Width of right lobe 18—20 cm.
	Width of left lobe 8—10 cm.
	Vertical diameter right lobe 20—22 cm.
	Vertical diameter left lobe 15—16 cm.
	Greatest thickness 6—9.5 cm.
Ovaries	7.0 g 4.5×2.7×1.3 cm.
Pancreas	66—102 g 19.×2.2×4.0 cm.
Prostate	20.0 g 4.5×2.7×2.0 cm.
Spleen	171 g 12.0×7.5×3.0 cm.

Spinal cord . .	33 – 38 g	. . . . . 44.8 cm. long in m. . . . . . 41.6 cm long in w.
Stomach	170—232 g	
Testicles	15—24.5 g	
Thyroid	30—60 g	. . . . . 6×3.5×2.0 cm.
Uterus (after births)	110 g	. . . . . 9×6 ×3.5 cm.

SPECIAL INSTRUMENTS AND APPLIANCES.

In this brief enumeration no attempt has been made to describe the complete outfit of the modern pathologic laboratory. The fully equipped pathologic institute or hospital dead-house will contain elaborate apparatus for special purposes which has been intentionally left out of consideration.

Many an examination must, of course, be made with few of the instruments and conveniences referred to; an autopsy can be thoroughly performed with a few knives, scissors, forceps and a saw. At the present time, however, the satisfactory and complete examination of a dead body requires the almost constant use of the microscope and its accessories; the tissues and fluids will frequently demand bacteriologic investigation; obscure medico-legal cases exact the aid of the microscopist, the bacteriologist as well as the chemist, and while the post-mortem examination in the majority of such instances is really only the first step in the investigation, yet everything depends upon the fact that the work must be complete and correct from the very beginning. Every fair-sized town or city should consequently provide a suitable place with all the necessary appliances in order to insure the completeness of examination which all medico-legal cases demand and all other cases merit.

A complete set of post-mortem instruments includes:

Knives.— For the long incisions and the coarse dissection the section knife of Virchow is employed. This knife is provided with a stout, deeply-bellied blade with a well-rounded point and a heavy, large handle, so that it can be firmly grasped with the whole hand. An extra heavy instrument of this kind can be used as a cartilage knife (Fig. 3). Ordinary dissecting scalpels are necessary for the more painstaking and delicate dissection required from time to time. The brain knife is a long, thin, frequently doubled-edged, sharp instrument used for incising the solid organs so that they may present smooth and extensive cut surfaces upon which the structural condition can be studied (Fig. 4). A curved probe-pointed bistoury is handy for cutting through the dura in removing the brain. A razor or a Valentine's double knife is sometimes employed for making thin sections of the fresh tissues.

Scissors.— Probe-pointed scissors are employed for incising vessels and canals of various kinds. Fair sized ordinary scissors with one blunt and one sharp blade are also necessary. The enterotome, useful for opening the intestines and also the heart, is a large pair of scissors, one of the blades of which is provided with a blunt, projecting extremity; this projection should be smooth, and free from any sharp points or edges that may catch in the folds of the intestinal mucosa or in the columnæ carneæ of the heart (Figs. 5 and 6).

Fig. 3.—Stout Knife.

Fig. 4.—Double Edged Brain Knife.

Fig. 5.—Properly made Enterotome with smooth blunt projecting point.

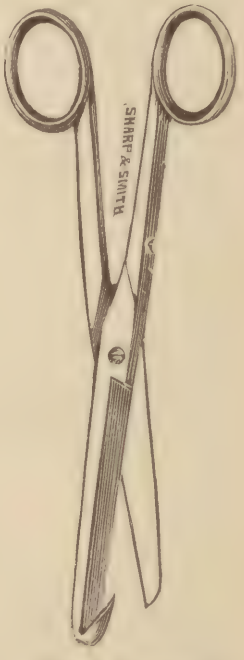

Fig. 6.—Improperly constructed Enterotome with sharp hook.

Dissecting Forceps.—Two or three pairs of different sizes.

Probes.—Large and small; also, grooved director.

Saws.—A butcher's saw will answer quite well. A bone saw with movable back and detachable blade with fine teeth and well set is preferable. For sawing the laminæ of the spinal column a saw with a curved handle and a rounded broad blade may be used or a double saw, like Luer's rhachitome. In removing portions from the base of the skull a key-hole saw is desirable (Fig. 7 and 8).

Chisels.—A chisel with a straight edge and a strong wooden handle, the blade being about 3 cm. broad, will answer very well. A T-shaped steel chisel is often placed in the case of instruments, and sometimes the blade has a guard placed on it, say one-third of an inch from the point, to prevent the chisel from injuring the brain in removing the calvaria (Fig. 9).

Brunetti's chisels for opening the spinal canal from the front are now considered unsafe because of their liability to produce artificial heterotopia in the spinal cord, but they may nevertheless be found very useful in private examinations (Fig. 10).

Mallet.—A heavy wooden or rawhide mallet (Fig. 11) drives the chisel better than the ordinary steel hammer, the blunt hook on the end of which is useful in jerking off the calvaria. A cross-handled hook is also useful for this purpose.

Bone Forceps.—Large, strong.

Lineal and Liquid Measures.—Every case of post-mortem instruments should include a cup of fair

Fig. 7.—Saw with rounded blade of convenience in sawing lamina of spinal column.

Fig. 9.—T Shaped Chisel.

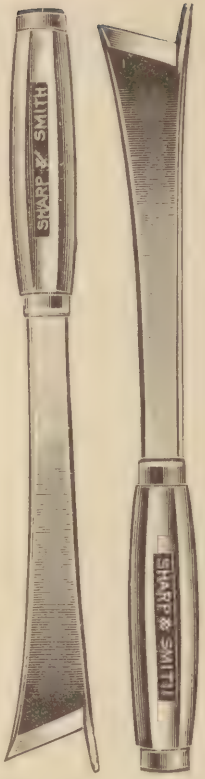

Fig. 10.—Brunetti's Chisels.

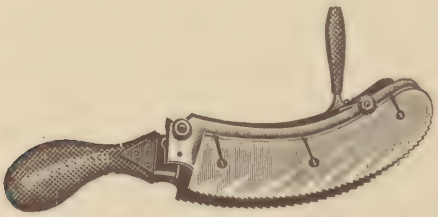

Fig. 8.—Luer's Rhachitome.

capacity for measuring fluids (Fig. 12); also a brass or wooden foot-rule graduated into inches and centimeters. Caliber compasses with graduated cross-bar are of course very handy. In autopsy rooms graduated glasses of all kinds must be at hand.

Scales. The weights must be suitably sub-divided In private and medico-legal work a pair of balances able to weigh altogether, say, 2,000 grammes will be found very useful. Weighing determines actual increase or decrease on part of an organ much more accurately than measurements. In large dead-houses scales should be arranged for the ready weighing of the whole cadaver; a fulcrum and lever arrangement underneath the post-mortem table would weigh the body as it is placed in position for the autopsy.

Graduated Cones.—These should be from a fraction of to several centimeters in diameter and are used for measuring orifices and tubular organs (Fig. 13).

Metal and Flexible Catheters.

Blow-Pipe with Stop-Cock.

Post-Mortem Needles and Barbour's Linen Thread No. 25.

Litmus Paper.

Sponges, Pails, Vessels, and Plates.

Magnifying Lens.

Microscope and Freezing Microtome and Adjuncts.—A microscope with the necessary adjuncts and a freezing-microtome, or, in lieu of this, a double-knife make a fairly definite diagnosis possible on the spot,

Fig. 11.—Rawhide Mallet.

Fig. 13.—Graduated Cone (inches).—*Hamilton.*

Fig. 12.—Beer Tester's Glass holding 300 ccm.

and it goes without saying that this method of testing the macroscopic diagnosis should be employed as frequently as it is possible.

Photographer's Camera.—This is an exceedingly valuable accessory for the accurate reproduction of the appearance and the location of wounds as well as of interesting pathologic conditions and specimens which for some reason cannot be preserved. All unknown bodies should be photographed as a possible means of future identification.

Tubes with Sterilized Media. These should be at hand ready for inoculation and the platinum-needle and alcohol lamp must not be forgotten.

Bottles and Jars.—Suitable clean, well-stoppered bottles and jars, provided with labels, and also some standard preserving and fixing solutions are absolutely necessary for the proper care of pathologic specimens and tissues, and in cases of suspected poisoning.

Injecting Syringes and Solutions.

EXAMINATION OF THE BODY.

The body is placed upon the table in the supine position; all clothing, including the stockings, is to be removed; the table, if movable, is placed in the most favorable light; whatever instruments are considered necessary are placed in order upon a suitable tray or board; pails, basins and pitchers with warm and cold water are at hand; in short everything is placed in order after the manner of the well-arranged surgical operation.

Under all circumstances the examination of the exterior of the body is always and invariably the first in order.

INSPECTION.

In a general way inspection determines the stature, the sex, the color, the height, the approximate age, the development, the degree of general nutrition, and the other usual characteristics of the body. Whenever possible the exact weight of the body should be established. In order to determine the exact shade of color in the skin the body must be thoroughly clean; otherwise there is great danger of not recognizing or of confounding with each other the various forms of accidental or morbid cutaneous discoloration. The state of the general nourishment is well shown by the fullness and roundness of form and by the degree of muscular thickness and prominence. The thickness,

the tension and the elasticity of the skin are determined by raising it into folds. Inspection takes particular notice of the signs of death, decomposition, and external pathologic or traumatic changes. The degree of rigor mortis present is determined; it must be remembered that cadaveric rigidity is first to show itself about the muscles of the lower jaw, from which it gradually extends downward; it disappears in the same sequence. The *livores mortis*, or post-mortem lividity, are of normal post-mortem occurrence; they are reddish or livid discolorations that appear most marked on the undermost parts of the dead body and they are due either to simple gravitation of the blood within the vessels or to the diffusion of the blood coloring matter into the perivascular tissue—sometimes so extensively as to map out the whole cutaneous network of veins. These gravitation and diffusion stains are to be distinguished from the greenish discolorations that are due to the changes of decomposition and which show themselves first where the viscera are nearest the surface, as in the lateral regions of the abdomen.

In medico-legal cases the nature of all areas of discoloration upon the dead body must be definitely settled, and the following are some of the more important points to take into consideration: their location, size, and shape; the effects of pressure upon removing the color; the exact color or colors observed; the absence or presence of elevation or tension over the area; and finally the condition of the underlying tissue as regards infiltration with fluid or clotted blood. Neither of the post-mortem discolorations are accom-

panied with surface elevation; extravasations usually are. The post-mortem hypostasis stain can be removed for a moment by pressure. Incisions through the skin must always be made for positive differentiation: the ordinary post-mortem discoloration will not show any free blood in the tissues outside the vessels; in extravasations, on the other hand, caused by contusions or other modes of violence, the tissues will be more or less extensively infiltrated with free fluid or clotted blood due to the rupture of the blood-vessels. It is to be recollected that blows upon the body within two hours after death may cause ecchymoses and extravasations which cannot, under some circumstances, be distinguished with certainty from some of those formed during life, and that decomposition, if somewhat advanced, may so change appearances that a correct interpretation may become very difficult.

The examination of the exterior of the body for pathologic or traumatic changes must be minute and systematic, and it should take up the various and several parts of the body in order. Commencing with the head, the scalp is to be examined for wounds and scars and the condition of the hair noted. The eyelids, the eyeballs, and the pupils are to be inspected: if one eye should be found to have been absent or useless for some time, then it might be very interesting and profitable to secure a reliable study of the visual tracts in the brain. The nose and the ears are to be examined for foreign bodies, for the presence of blood and other fluids. The color of the lips and the nose should be noted; the condition of the teeth, the situation of the

tongue, the presence of fluids or foreign bodies in the mouth are all points of great importance in medico-legal cases. Sometimes rigor mortis closes the mouth so firmly that it becomes necessary to pry it open with a chisel inserted between the teeth. The neck is to be closely examined for livid spots and marks of violence, glandular enlargements, etc. The fullness of the mammary-glands and the absence or presence of milk should be noted in women. The degree of abdominal distension, the presence of *linea albicantia*, the condition of the inguinal and crural regions with reference to evidences of hernia are points to be investigated. In women that are suspected to have died from the results of abortion the external genitalia are to be carefully examined for ruptures and lacerations, for punctures and other wounds, for foreign bodies, inflammatory lesions, and peculiar discharges. In cases of assault the fluids present must be carefully examined with the microscope for spermatozoa, and suspicious stains upon the clothing should also be investigated in this respect. The anus is also to be inspected for inflammatory and other changes as well as for foreign bodies. The glans penis and the prepuce require careful search for syphilitic and other cicatrices. The inspection of the surface of the back must not be neglected. Finally the extremities are taken up and examined for edema, ulcers, scars, deformities, gouty deposits, evidences of external injuries, such as fractures, etc.

In ulcerative endocarditis, purpura hemorrhagica, and some of the acute exanthematous diseases the skin

and subcutaneous cellular tissue may show important and interesting lesions and blood extravasations which would merit careful histologic and bacteriologic study.

In medico-legal cases particular attention is directed to the following special points: All wounds must be accurately described and located with reference to fixed anatomic landmarks; thus, for instance, the course pursued by missiles in passing through the body must be as definitely established as possible, because important evidence may be elicited in that way as to the relative position of the assailant and the victim at the time the firearm was discharged.

With reference to wounds it is also to be noted that all evidences which tend to warrant any conclusions as to their ante- or post-mortem occurrence must be carefully studied. Penetrating wounds are not to be carelessly or indiscriminately probed because of the great danger of possible rupture of the walls of important cavities and thus hopelessly complicating the question of the extent of the original wound. Careful dissection should invariably be employed to determine the course and the direction of wounds, and occasionally, in exceptional cases, this can best be done after the cavities of the body have been opened: as a general rule the external examination should be completed before any of the cavities of the body are opened, because thereafter turning of the body becomes very undesirable and the anatomic relations are often quickly disturbed.

The physical and other peculiarities to be taken note of in the case of unknown persons, have been

called to mind on page 10 in connection with the post-mortem record.

In medico-legal cases the external inspection may include an examination of the clothing upon the body for tears, holes, stains, and also of the premises where the body was found and the surroundings, for the purpose of discovering, if possible, anything that may throw some light upon the cause or mode of death. Particular attention should be paid to the position of the body with reference to the furniture, to blood stains, to vomited material; to glasses, powders, or bottles; instruments that may be found should be placed under lock and key for the time being; any stains upon the carpet, the bed-clothes, or the personal clothing may have to be cut out and preserved for examination; under all circumstances a thorough description is made of everything observed and a record made of the disposition of the articles referred to. In some instances a photographic view of the room or premises may be very valuable.

THE ORDER OF THE INTERNAL EXAMINATION.

The order in which the large cavities of the body may be examined is subject to considerable variation depending upon the nature of the case and also somewhat upon the place where the examination is made.

In medico-legal cases it is the custom to direct attention first to that part of the body in which there is reason to believe that the cause of death will be found and then to examine the remaining cavities in whatever order may seem natural or convenient. In certain

cases it may be advisable to open all the cavities and to display such organs as the heart and the brain prior to incision or removal in order that they may be examined as nearly simultaneously as possible with reference to the amount of blood contained in them. This should be done in order to avoid possible disputes as to the effect upon the amount of blood in either organ the removal of one before the other might have. It is frequently stated that the cutting of the large veins at the base of the heart disturbs the quantity of blood in the brain and its membranes; this quantity is largely dependent on post-mortem circumstances, however, and the cutting of the large veins does not in any way alter the amount of free fluid in the encephalic and cranial cavities; so that, as far as the quantity of blood is concerned, it really seems to be a matter of but little importance which part is examined first, except that in order to avoid unprofitable contentions it may be well in specially selected instances to expose the contents of all the cavities before removing any of the organs.

In ordinary cases the most frequent order of examination should be from above downward, viz., cranial, thoracic, and abdominal cavities. Often, however, the suspected existence of grave lesions within the organs in the latter cavities will change the order. It will be seen a little later on that while the abdomen is opened before the thorax, yet it is examined later. In case the spinal cord is to be removed, then it would be advisable to do so the very first thing or immediately after the removal of the brain, in case the post-mortem examination is made at a private resi-

dence, because to turn the body over on the anterior surface after having opened and examined the thorax and abdomen is under all circumstances a very uncleanly procedure. In a hospital post-mortem room this objection is in the main removed on account of the specially constructed tables, and the cord might as well be removed during the latter as during the early part of the autopsy, but the intimate physiologic relation between the brain and the cord demand that under all circumstances their examination be as connected as possible. In medico-legal cases turning of the body might modify the relative position of parts, as in the case of incised wounds, and for this reason the vertebral canal might best be left to the last in such instances.

From these fragmentary considerations it will be observed that no set rules can be laid down as to the order of the examination; in the individual ordinary or medico-legal case the order should be such as would cause least disturbance in the parts that remain.

"The individuality of the case must often determine the plan of the examination, but we must not begin with individualizing nor make a rule of the exceptions."

THE SPINAL CANAL.

The body lies prone, the neck and upper chest resting on a wooden block. A continuous incision is made from the occipital protuberance along the spines down upon the sacrum, and the skin and subcutaneous tissue is then dissected loose for a short distance on each side of the median line. Deep incisions are now

made through the muscles and the fascia attached to the spines and all soft tissues are dissected away from the laminæ out to the articular processes so that the vertebral arches are fully exposed. Morbid conditions of the soft parts and fractures of the bones can now be looked for. The laminæ are next sawn through near the articular processes, so as to open the spinal cavity at its outer borders; with Luer's rhachitome, the adjustable, double-bladed vertebral saw, this is quite readily accomplished simultaneously on both sides, the distance between the saw blades being regulated so as to fit the individual spine. A single-bladed saw, curved and round at the point (Fig 7.) accomplishes the same result with a little more labor, but with a somewhat greater degree of safety to the integrity of the cord, as the double saw will be found liable to impaction in the saw grooves in the curved regions of the spine and the sudden jerks and thrusts applied in order to loosen it may force the blades down upon the dura or the cord with more or less injury to the latter. The entire posterior archway should be sawed through completely so that every spinous process yields readily to manual pressure or traction, and this should be fully accomplished without the use of any of the various forms of chisels or of bone pliers recommended for the purpose of hastening the removal of the cord; then the ligamentous structures between the atlas and the occipital bone are cut across, and the entire loosened posterior arches held together by the ligamenta subflava may be removed at once with a strong forceps or hook; or the removal may be commenced in a similar way from below.

The use of the mallet and chisel or of cutting bone forceps in opening the spinal canal for the purpose of removing the spinal cord cannot be recommended any longer because Van Giesen[1] has recently shown in a very thorough manner the great danger of mechanical disturbances in the cord substance when such violent procedures are resorted to. He has quite conclusively demonstrated that autopsy bruises and jars may cause topographic alterations and dispersions in the gray and white matters of the spinal cord, as well as minute structural changes, and that a number of the cases described in the literature as instances of heterotopia, or malformation of the cord, are in reality only the result of mechanic disturbances due to faulty post-mortem technique. When the laminæ are completely sawed through and the connected posterior archway torn off in the manner above indicated, then the liability of extensive as well as deceptive artefacts due to bruises and jars is reduced to a minimum; the saw may, of course, be driven through the laminæ and against the dural sac, but with a properly shaped saw, carefully handled, the chances of injury to the cord must be considered very slight as compared with the chisel and hammer procedure.

The spinal cord can also be taken out after the removal of the vertebral bodies by means of Brunetti's chisels (Fig. 10), the pointed guard of which is inserted into the vertebral canal between two pedicles against the upper one of which the cutting edge rests, the long axis

[1] Ira Van Giesen. *A Study of the Artefacts of the Nervous System*. Appleton & Co., 1892.

of the chisel being parallel to the vertebral column; the pedicles are then cut off on both sides by means of blows from the mallet. In this way the spinal cord is expeditiously removed through the long anterior incision into the body after the organs have been taken out, and the method may therefore be of advantage in limited or private autopsies, but there remains the danger of mechanic damage to the cord.

THE SPINAL CORD AND COLUMN.

After the removal of the arches the posterior surface of the dura and the condition of the spinal canal as to abnormal contents can be studied. The dura may now, if so desired, be incised by means of probe-pointed scissors along the median line posteriorly, and the subdural space as well as the pia can then be inspected and the consistence of the cord carefully estimated by means of gentle palpation with the finger. On account of the greater danger of damage to the cord under these circumstances, it is best to always remove it within the intact dural sac whose attachments to the bony walls of the spinal canal are very loose. The spinal nerves are first cut across with a long, sharp-pointed, thin-bladed knife as far into the intervertebral foramina and away from the dura as possible. Dividing the branches of the cauda equina, the lower end of the cord is then carefully loosened from its bed and lifted up by means of a pair of forceps pinching a fold of the dura, and while the left hand holds the cord out of the way in this manner, the right severs the anterior attachments between the dura and the canal. Lastly,

the cord and the dura are cut across as near the occipital foramen as possible, or they may simply be extracted, in case the brain has already been removed. In the latter instance it must not be forgotten to cut the dura across just below its attachment to the margins of the foramen magnum.

During these manipulations great care must be exercised not to bend, twist or compress the cord, which should not be grasped directly, but always by means of forceps pinching up a fold in the dura. After its removal place it upon a smooth board of suitable length with, let us say, the posterior surface downward. The dura is now carefully incised along the median line anteriorly, and the contents of the subdural space, the inner surface of the dura, and the pia examined; then the cord may be gently turned over and the same process repeated as regards the posterior part. The dura is then removed from the cord by cutting with sharp scissors the spinal nerves and the ligamenta denticulata on each side.

The further treatment of the cord will depend upon the purpose of the examination. If it be intended to make a thorough histologic study, then the purposes of such investigation will undoubtedly, in the majority of instances, be best subserved by at once suspending the cord in the long glass jars usually provided for this purpose, filled with bichromate solution. A small weight may be attached to the cauda equina, in order to maintain the cord in a perfectly straight position. Palpation and incision should be studiously avoided in these instances, especially where foci of

softening of various kinds are thought to exist, in order that artificial displacements and bruises can be entirely eliminated; the examiner must be content with inspecting the cut surface of the upper extremity.

On the other hand, if it be concluded to examine the cord substance macroscopically first, and perhaps to prepare for microscopic study such parts as may subsequently be selected for various reasons, then the whole length of the spinal cord may be gently and delicately palpated with the clean index finger, in order to estimate, if possible, variations in consistence, foci of softening or of sclerosis. Then it is cut into transverse sections, say one inch in length, with one stroke of a moist, sharp razor or thin scalpel, which leaves the segments attached to the pia; the knife should be moistened before each cut, and care should be taken not to compress the cord as the sections are made, so as to avoid bruising the cord as well as to prevent the myeline from running out upon the surface to any greater extent than is absolutely necessary; cords in which foci of softening are detected by palpation ought not to be incised at all in the damaged regions, if microscopic examination be determined upon, because if incised the softened substance may flow out to such an extent as to completely disturb the topographic arrangements.

The condition of the columns of white, and the horns of grey matter, the central canal, and a variety of morbid lesions can be made out fairly well upon the cut surfaces of the cord of good consistence, exposed in the way indicated, but it is to be recollected

that the naked eye examination of this organ is, after all, somewhat unsatisfactory and never to be solely relied upon. If the cord is to be hardened after having been divided into segments, then place it upon a quantity of absorbent cotton, in a wide jar, so that it rests in an easy coil which exposes the cut surfaces to the action of the fluid; during the early process of hardening more myeline may be driven out upon the free surfaces of the segments.

Moderate traction upon the intact dura will usually lift the spinal ganglia out of the intervertebral foramina so as to permit of their removal in connection with the spinal nerves; chiselling away of the articular processes after removing the cord renders the ganglia readily accessible, and their removal free from danger of injury.

After the removal of the cord the structures composing the canal can be examined for fractures, displacements, morbid processes of various kind; sometimes, in order to study the exact location of fractures or other lesions, it may be necessary to remove a segment of the spinal column itself, which is quite readily accomplished by cutting through the intervertebral cartilages above and below the portion to be removed, then dissecting away the soft parts thoroughly, severing the bony connections by the judicious aid of the hammer and chisel or saw.

THE COVERINGS OF THE CRANIAL CAVITY.

The body is supine, the head at the end of the table, the neck and occiput rest on a block which

brings the head well forward. The hair, especially when long as in women, should be carefully parted along the line of the proposed incision which runs from the apex of the mastoid process behind one ear over the vertex to a corresponding point on the opposite side. This incision is to be made with a heavy knife, one firm stroke of which divides the soft parts clear down to the bone (Fig. 14). It has been recommended, after transfixion of the soft parts, to cut outwards in order to save the edge of the knife and in order to cut off as little hair as possible. In medico-legal cases, with injury to the scalp, the incision should avoid such wounds as much as possible so as not to interfere with measurements or localization. The division of the soft parts should be especially complete at the beginning and at the end of the incision, because at these points the soft parts are intimately adherent to the bone, and if not loosened thoroughly the scalp cannot be easily reflected. The scalp is now reflected by dissection, by traction, and by pushing with a chisel inserted between the skull and the pericranium, anteriorly as far as the supra-orbital ridges, posteriorly down to the external occipital protuberance, and laterally down to the external auditory canals, the scalp being folded upon the face and underneath the occiput. The soft parts may be reflected only down to the pericranium, in case there is reason to expect morbid changes in the periosteum and the bone; after examination it can be scraped off with a chisel or it can be divided down the bone along the line of the proposed saw incision for removal of the vault. The temporal muscles are to be

left intact beneath their fascia, but divided down to the skull in the line of the incision referred to.

The surfaces thus exposed are to be carefully examined for traumatic lesions, hemorrhage and the various forms of inflammation. The external surface of every skull always merits a conscientious study in regard to premature synostosis or persistence of the sutures, supernumerary bones, asymmetery, as well as the various special morbid conditions. Two diameters should always be taken of the skull, namely the transverse and the longitudinal; in the mesocephalic skull the ratio of the transverse diameter to the antero-posterior is as 70-80 to 100; if the transverse diameter be less, then the skull is known as dolichocephalic; if it be more it is called brachycephalic; abnormally shaped skulls will thus be recognized and measured. By applying strips of lead to the surface of the skull, the various outlines may be taken and transferred to paper; there are three principal outlines: the one in the greatest circumference in a line with the center of the forehead and the occipital protuberance: the second from root of nose to occiput; the third from one mastoid process to the other.

The skull cap is now removed by means of the saw; the incision should follow a line which runs on both sides from the centre of the forehead to the base of the mastoid process and from these points backward and upward to a point a little above the external occipital protuberance, thus separating a wedge-shaped section of the calvaria; the temporal fascia and muscles are divided with the knife in the line of this incision;

when the skull cap is removed in this way it is easier held in place again by means of a suture or two in the temporal aponeurosis and thus undesirable disfigurement of the corpse is readily avoided. Otherwise the incision may be circular, running from the glabella to the occipital protuberance on each side; this skull-cap can be held in place by means of sutures passed through drill holes or by means of double-headed carpet tacks.

While sawing with the right hand the left hand applied to the face steadies the head which is twisted from side to side as convenience demands; while sawing posteriorly it may be necessary to stoop down as the field cannot always be brought into view otherwise; the saw furrow should be continuous and even, and the brain must not be injured. The average thickness of the skull is about 0.3 *cm.*, thinnest at the temples and in the temporal fossæ, thickest at the occiput; the sawdust from the external table is white, from the diploë red, and white again from the internal table; as the skull is cut through there is a sudden sense of diminished resistance; by bearing these points in mind it will be possible to guard against brain injury.

In medico-legal cases the skull should be sawed completely through all around so as to avoid entirely the use of the chisel and mallet which might produce, or be alleged to produce, misleading fractures. In clinical cases the calvaria may be cracked off with the cautious use of the chisel and hammer after sawing partially through the bone. The saw incisions should meet accurately as fractures are most readily produced at the points where the ends fail to meet.

The calvaria is usually easily loosened by inserting a chisel or cross-bar between the sawcut margins and twisting them on their long axes, after which a blunt hook may be inserted, preferably posteriorly, and the cap suddenly jerked away from the dura; it is dangerous to use the fingers for this purpose as skin abrasions and scratches may result.

If the dura be so unusually and so firmly adherent to the inner surface of the skull that traction seems likely to cause injury to the brain, then the dura must be divided with probe-pointed scissors along the skull incision and, after cutting the falx cerebri across near its anterior attachment, the skull-cap and dura are removed together; this method must always be used in children under seven years of age, because up to that time the dura is firmly attached to the bone as its internal periosteum. In these instances of normal or pathologic adhesions of the dura, it can usually be torn away after removing the skull-cap; it happens, however, that sometimes it cannot be torn away, and then the longitudinal sinus must be incised with the dura attached to the bone. Ordinarily the calvaria comes away readily enough, leaving the dura covering the brain.

The sawn edges, the relative thickness of the outer and inner tables and the diplöe, the condition of the inner surface of the skull can now be examined in all necessary detail (Fig. 14).

The external surface of the dura is next examined; its color, the condition of its vessels, the presence of Pacchionian bodies upon the external surface, etc., are points to be noted as well as the morbid changes that

may be present. The degree of tension should always be tested by pinching up a fold near the apex of the frontal lobes; with the body on the back it should be possible to raise a small fold in the locality indicated; if a large fold is easily picked up, then the intracranial contents are diminished, while if no fold at all can be made, there is increased cerebral pressure. The longi-

Fig. 14. Removal of calvaria; the dura over the right hemisphere reflected upon the left.

tudinal sinus is now to be incised with scissors or with a small knife, the dura on each side being stretched by the fingers of the left hand, in order that its contents and the condition of its lining may be examined.

The next step consists in dividing the dura on each side near the sawn edge of the skull from the anterior to the posterior extremity of the falx cerebri;

this can be done with a thin, narrow-pointed knife, or with small probe-pointed scissors, care being taken not to puncture the pia; the dura over each half of the convexity is then folded in turn over upon the opposite half so as to expose the under surface to full view and examination; at this time the condition of the subdural space with reference to abnormal contents as well as the color and vascularity of the pia over the convexity, always comparing the two sides, are to be carefully noted; if adhesions be found between the dura and the pia, then the corresponding dural area should be cut away from the membrane and allowed to remain adherent to the pia instead of being separated forcibly with perhaps such damage to the subjacent cortex as to render a histologic examination useless.

In order to sever the anterior attachment of the falx to the crista galli preliminary to removing the brain, a narrow, sharp knife is passed down parallel with and to the left of the falx with the edge forward until the point rests upon the cribriform plate; then the edge is turned to the right and, as the dura is made tense by drawing it upward and backward with the left hand, the falx is cut across; the edge is then turned forward again so as not to cut into or contuse the brain on withdrawing the knife; there will be felt a giving way of all resistance as the falx is completely severed. The dura may be left attached to the brain during its removal, or it may be gradually and carefully torn away from its adhesions to the pia by means of the Pacchionian granulations and the superior cerebral veins on each side of the longitudinal fissure and left hanging

down at the occiput; if it be intended to inject the brain, then the dural covering of the hemispheres had best be left in situ so as not to disturb the pial veins as they enter the longitudinal sinus.

REMOVAL AND EXTERNAL EXAMINATION OF THE BRAIN.

Place the block under the neck so that the head hangs backward just a little; carefully pass the fingers of the left hand between the skull and the frontal lobes and gently draw these backward so that the olfactory bulbs are brought into view; as the brain mass now slowly leaves the cranial cavity by its own weight, resting all the while in the left hand, the optic nerves are divided at their foramina, the internal carotid vessels are cut across as they penetrate the dura, and the hypophysis and nerve trunks that successively come into view are severed as near the dura as possible, with a narrow-pointed knife that always cuts against the bone so as not to injure the brain; the temporo-sphenoidal lobes are lifted out of the middle fossæ and the tentorium, which has now been reached, is to be cut with the point of the knife, precisely at its attachment to the superior margin of the petrous portion of the temporal bone commencing at the left sinus transversus and going with a sawing motion inward to the posterior clinoid process, and then, on the right side, outward in reverse direction; the knife point penetrates the thickness of the tentorium only, and great care is taken not to cause injury to the cerebellum; during and after the division of the tentorium the brain mass is carefully supported with the left hand so as to prevent laceration of

the base from its own weight, as the only natural support it can now have comes from its connection with the spinal cord. The numerous nerve trunks about the pons-medulla transition are now cut as near their exit as possible, and finally it only remains to divide the spinal cord and the vertebral arteries as far down in the spinal canal as possible; for this purpose the knife is passed down with its edge to one side and the cord is severed by means of one decisive stroke accompanied with elevation of the handle of the knife so as to make the division at as near a right-angle as possible; the vertebral arteries are to be cut on each side. In order to secure vertical cut surfaces where the cord is divided, which may be very desirable for the purpose of the microscopic examination, the myelotom of Pick may be used to very good advantage (Fig 15). If the cord has

Fig. 15.—Pick's myelotom.

already been removed, then it may be necessary to simply divide the vessels and the nerves on each side of the remaining portion, which is then extracted through the foramen magnum as the brain is raised from its cavity.

All the structures that are connected with the brain have now been severed, and while the left hand supports it as before the fingers of the right are placed upon the inferior surface of the cerebellum so that the medulla rests between them, and the whole mass is then lifted bodily out of the cranial cavity; if the dura has been left upon the upper surface, then it is divided with scissors at the occiput. The base of the skull is

now examined for abnormal contents and any free fluid may be collected or estimated as to quantity.

If the brain is to be injected and hardened before its interior is examined, then the organ should be first weighed and its various surfaces carefully inspected while it is yet fresh and before the commencement of any of those more elaborate procedures necessary in order to produce a successful and instructive hardened specimen. The pia should not be lacerated at any point and a special attempt should be made to leave the vessels at the base as long as possible in the brains which it is proposed to inject and harden; means for he commencement of these processes must be close at hand, and the brain, while fresh, must be carefully guarded against contusion and distortion if it is necessary to transport it for some distance.

If the brain is to be cut open immediately after its removal, it is first weighed and then placed base upward upon a smooth, firm, easily movable tray or board of considerable extent, and the lateral and basal pial surfaces carefully examined together with the cranial nerves and the vessels at the base.

The arteries at the base and in the Sylvian fissures require careful, routine examination on account of the comparatively frequent occurrence of important changes such as arterio-sclerosis, embolism, thrombosis, aneurisms, etc.; consequently the pia-arachnoid covering them should be picked off, and the layer of arachnoid which bridges the Sylvian fissures should be incised and the temporo-sphenoidal separated with the fingers from the parietal lobes so as to expose the middle

cerebral arteries throughout their whole course; the frontal lobes should be separated so as to bring to view the anterior cerebral vessels as they curve over the corpus callosum; the posterior cerebral arteries are also to be traced backward between the cerebellum and the occipital lobes. All the arteries should be opened longitudinally as far as possible with fine scissors so that the interior can be completely examined.

Having thoroughly finished the examination at the base, the brain is turned over and a systematic study made of the general contour, fissure formation and peculiarities of the cerebral surface.

Removal of the pia is indicated whenever it is desired to determine whether or not it is abnormally adherent to the brain surface, in order to study the size and form of the convolutions and also in order to facilitate accurate localization, because it is rather difficult to trace the gyri and fissures while covered with this membrane. It must be recollected, however, that the pia should not be stripped away from those parts of the cortex that are to be examined microscopically because of the large number of pial vessels that enter and leave the brain, the tearing out of which necessarily disturbs the cortical structure considerably. Small portions should consequently be removed for microscopic examination with the pia still adherent.

In order to remove the pia the artery of the corpus callosum is cut across in front and at the posterior border, the intermediate portion is to be grasped with forceps and the pia detached slowly and carefully, little by little; when the convexity is reached

the free membrane may be grasped with one hand which continues the stripping while the other hand pushes the brain away from the pia; should the pia tear at any place pick it up again with forceps at the bottom of a sulcus in which run the larger and stronger vessels. A stream of water running gently over the brain will assist the removal greatly.

On removing an adherent pia a layer of cortical substance will remain attached to it; in order to accurately localize such a district and in order to preserve it for microscopic examination the pia may be detached on all sides up to the margin of the adhesion, over which it can be left undisturbed.

After removal of the pia the general form of the convolutions, whether broad or narrow, flattened or sharp, surface depressions and discolorations, areas of cortical softening, of large and small hemorrhages, and a number of other lesions are readily studied.

SECTION OF THE BRAIN.

The method of sectioning the brain will vary according as the object of the examination varies. If the case is a medico-legal one and it is necessary to determine at once and positively the presence or absence within the brain of actual or contributing causes of death, then the somewhat mutilating method of Virchow, or some slight modification thereof, may be employed to good advantage. By this method the brain mass may be sufficently subdivided to discover even quite minute macroscopic lesions while the topographic relations are fairly well maintained.

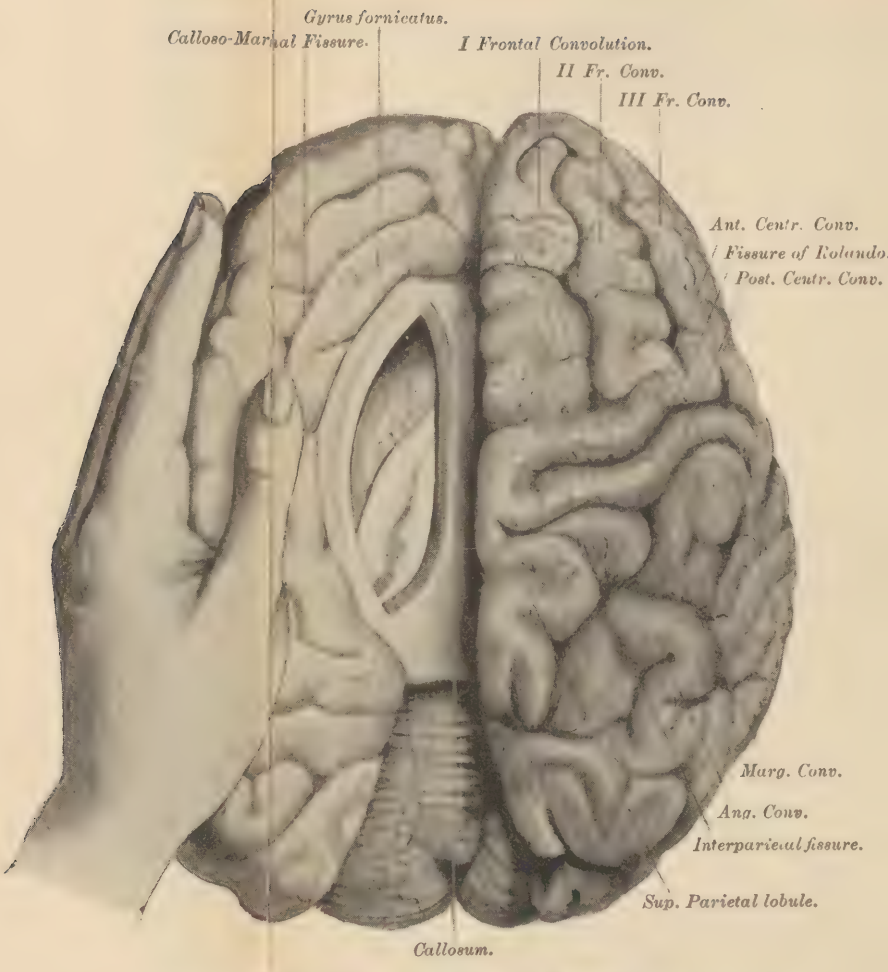

Fig. 16.—Section of the brain.—(Nauwerck).

The left lateral ventricle has been incised at the junction of the corpus callosum with the median surface of the left hemisphere; the red lines show the direction of the incisions that will lay the ventricle widely open.

A brain divided after Virchow's directions cannot, however, be subjected with any degree of success to the modern methods of fixation and hardening for the purpose of studying degeneration tracts, etc., because the dissection is too mutilating.

When it is not necessary to minutely subdivide the brain, then the method of hardening in toto in Müller's fluid and subsequent division into a number of transverse sections, as advocated by Hamilton, may be employed if the space and necessary apparatus for continuous injection be at hand.

Otherwise Meynert's method affords an opportunity to study all the more important structures while the brain is divided into parts which are suitable for fixation and hardening at the same time preserving the topographic relations.

Virchow's Method (Modified).—The brain lies base downward (Fig. 16). The left ventricle is usually opened first and the frontal apex should point away from the operator. The two hemispheres are carefully separated until the corpus callosum is quite completely exposed. If the brain is at all soft great care must be used least the corpus callosum falls apart. Place the left hand on the left hemisphere in such a manner that the fingers rest upon the superior and external surface while the thumb is applied to the median aspect and lift the whole hemisphere a little out and upward (Fig. 16). Then with a sharp knife the right hand makes a shallow, vertical incision into the roof of the ventricle in the angle formed by the junction of the corpus callosum with the median surface

of the hemisphere; this incision is continued backward and forward the whole length of the corpus callosum, opening the ventricle fully without any injury to the floor; then expose the posterior horn by cutting backward and outward into the occipital lobe, and the anterior cornu by dividing the frontal lobe in a direction a little outward and forward. Turn the left brain mass a little outward so as to open the lateral ventricle quite fully, then connect the two extremities of the incisions into the frontal and occipital lobes by a nearly vertical cut which passes through the floor of the ventricle outside of the basal ganglia down to the cortex of the inferior surface, allowing the left hemisphere to fall outward by its own weight.

On the right side the lateral ventricle is opened and exposed in the same way after turning the tray around so that the frontal apex points toward the pathologist.

Both lateral ventricles are now fully opened and their size, contents and walls are examined; the choroid plexuses can be extracted, or if it is desired to open the middle or descending cornu this can be readily done by an incision commencing at the opening of the cornu and extending forward and outward.

The corpus callosum has been carefully maintained in the median line during these manipulations and it is now lifted up with the left hand and a knife point enters through the foramen of Monro, the corpus callosum and the fornix being divided forward and upward; the parts behind this division are raised up and turned backward, leaving the velum interpositum uncovered; after examination of this structure and its choroid plexuses

it is also to be carefully raised up, the large veins that enter it from the basal ganglia are cut across with a knife, and the velum is then detached from the pineal body and the corpora quadrigemina.

The third ventricle is now fully exposed and the structures forming its walls can be inspected. The right posterior pillar of the fornix is then divided and the callosum, the fornix, and the velum interpositum are placed over to the left of the median line (Fig. 17).

In order to open the fourth ventricle the fingers of the left hand are placed underneath the pons and the cerebellum which they support in such a way as to elevate the vermes slightly; then a vertical incision is made with the right hand as exactly through the centre of the vermes as is possible, and as the cerebellar hemispheres fall out to each side by their own weight the ventricular cavity comes into view, the incision being carefully prolonged in both directions until the entire roof of the ventricle is divided and the Sylvian aqueduct opened; it is well to remember that the roof of the fourth ventricle is thinner in front than behind.

The whole series of encephalic cavities has now been opened and they can be examined at leisure with reference to size, contents, and the condition of the ependyma. Should the ventricles contain a large amount of fluid the brain ought to be weighed again after allowing the liquid to drain away.

The cerebrum is now to be further examined in the following manner (Fig. 17): Support the everted left hemisphere with the left hand, and divide it from before backward into halves by means of a long vertical incision

which extends down into the cortex of the under surface and yet does not completely sever all connections between the two parts; each resulting wedge-shaped half is again bisected in the same way, the incisions running along the upper sharp ridge down to the convex under surface of the brain mass, which is supported by the fingers of the left hand, a slight upward movement serving to make the cut surfaces fall apart; this process of bisecting is continued until in the judgment of the examiner the subdivision has reached a sufficient degree of minuteness, and then the tray is turned and the right hemisphere is incised in the same manner, but in the reverse direction, *i. e.*, from behind forward.

These incisions, like all incisions into the brain, should be made with one long stroke of a sharp, smooth brain knife, which is rinsed in water between each cut, so that the surface presented may be clean and smooth, in order that the degree of vascularity, the relation between the grey and white matters, and any focal lesions that may be present can be studied under as favorable circumstances as possible (Fig. 17).

The basal ganglia, the thalamus and the striate body may be next examined by means of a number of transverse incisions which, commencing at the anterior extremity of the striate bodies, divide the ganglia into a number of sections, each about 5–7 *mm.* in thickness; each cut should be carried through corresponding portions of each ganglion, so that as nearly as possible the same surfaces may be presented on either side for comparison. In making these transverse incisions the fingers of the left hand are placed under the district to

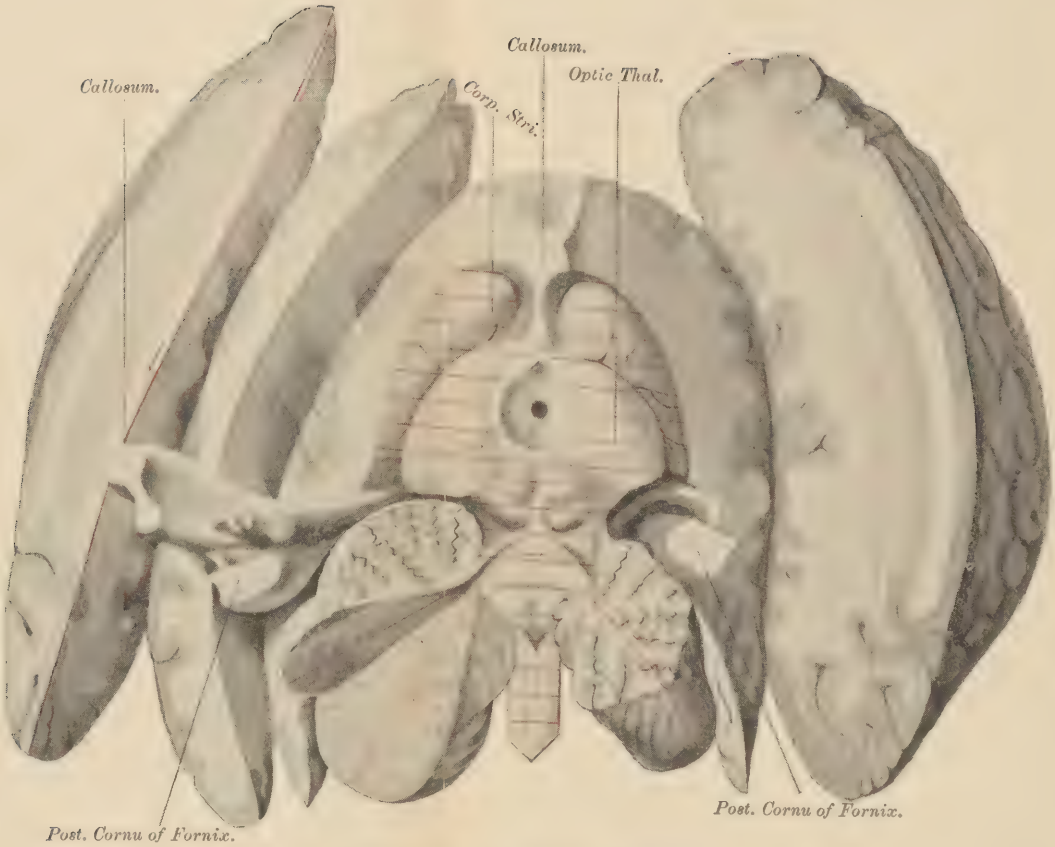

Fig. 17.—Section of the brain.—(Nauwerck.)
The red lines shows the course of the incisions that subdivide the various portions of the brain.

be incised, and by an upward movement the cut surfaces are made to fall apart. The incisions are made with a moistened knife, one stroke of which from left to right divides the ganglia down into the cortex of the base of the brain without completely severing the parts.

The great ganglia are also very frequently laid open in the direction of their fibres by a series of radiating incisions whose common point of origin is the cerebral peduncle on each side, whence the cuts radiate like the sticks of a fan.

The cerebellar hemispheres, already separated through the centre of the vermes by the opening into the fourth ventricle, are now further divided by a cut into each hemisphere which runs from the ventricle along the middle branch of the arbor vitæ down into the cortex of the convex surface; each resulting half is further bisected by incisions which run in the same direction (Fig. 17).

Now place the left index and middle finger under the medulla and the pons, so that the spinal cord rests in the palm of the left hand; raise these structures so that the cerebellar hemispheres fall to the sides, and then divide them by a number of transverse incisions which in turn pass through the corpora quadrigemina, the peduncles, the medulla, the pons, and the spinal cord. Or the hemispheres are first folded together like the leaves of a book, restoring the brain to its normal shape; it is then turned on its transverse axis and the pons, medulla and spinal cord are then cut into thin, transverse sections from the basal surface; the right

and left cerebral peduncles may be laid bare and incised at the same time.

After the section of a brain in this manner the various parts are still so connected that the brain may at any time be restored to its normal shape, with its component structures in their normal relation to each other; in this way localization of the various lesions is quite accurately accomplished. The order of procedure is frequently different from the one followed in the description. Thus the left hemisphere may be incised immediately after opening the left lateral ventricle, the right half after opening the ventricle on the side, and the ganglia may be incised immediately after the removal of the callosum and the velum interpositum, and so forth; but inasmuch as the series of encephalic cavities are all connected it would seem more natural to first lay them all open to comprehensive inspection, after which the brain itself may be cut into in the way described with equal advantage. It goes without saying that frequently slight variations and modifications of the classical method described will become necessary on account of the peculiarities of the individual case as well as the purpose for which the examination may be made.

The Transverse Section Method of Pitres and Hamilton. There are, of course, many and valid objections to minutely subdividing all brains according to the method known as Virchow's.

Gross or system lesions may be known to exist, the nature, the exact extent and seat of which it may be important to determine accurately at the same time

permanent preparations are made. For this and similar purposes the method of dividing the fore-brain into a number of transverse segments introduced by Pitres, modified and advocated by Hamilton, will be found useful and satisfactory. This method can be applied to fresh and preferably to brains hardened in Müller's fluid.

The first step consists in removing the pons, medulla and cerebellum by a transverse incision into the crura cerebri at the middle; these detached structures can be incised, if desired, in the manner already detailed after first opening the fourth ventricle through the vermes, then dividing and subdividing the cerebellar hemispheres into halves, and finally carrying a progressive series of transverse incisions through the pons, medulla, and cord.

In order to fix the brain-mantle in one definite position, it is recommended by Hamilton to place it vertex downward upon a board with the tips of the frontal and occipital lobes in a horizontal line perpendicularly to which a number of transverse sections are made.

According to Pitres' original method the sections ran parallel to the fissure of Rolando and were consequently not transverse to the long brain axis.

According to Hamilton's plan Section I runs through the anterior half of the third frontal convolution; Section II passes through the tip of the temporosphenoidal lobe and the operculum; Section III is made immediately in front of the optic chiasm; Section IV runs through the infundibulum; Section V traverses the

corpus albicans; Section VI passes through the anterior margin of the pons, and the VIIth and last Section runs across the front of the angular gyrus (Fig. 18).

The prefrontal section of Pitres passes through the anterior half of the third frontal convolution, the pediculo-frontal section runs 2 *ctm.* in front of the fis-

Fig. 18. Perpendicular transverse section of human brain, Section III.—(Hamilton).

sure of Rolando; the frontal section divides the ascending frontal convolution; the parietal section bisects the ascending parietal convolution; the pediculo-parietal section passes 3 *ctm.* behind the fissure of Rolando; the occipital section cuts across the occipital lobe. On each section the white substance is divided into definite

areas, known as fasciculi with distinct names which may be used in the descriptions of lesions, thus facilitating accuracy of observation, and such sections made according to either of these plans, hardened and mounted, make instructive and beautiful permanent specimens (Fig. 18 and 19).

Meynert's Method. The object of this method, which has been extensively adopted by neurologists and in insane hospitals, seems to have been to determine the relative weight of the brain mantle, the brain axis, and the cerebellum at the same that an excellent topographic view of the various tracts and coarser structures is obtained. This plan allows inspection with the eye of all the more important parts in the fresh specimen and the topographic relations are so maintained that fixation and hardening will produce valuable preparations. The following description is introduced verbatim from Blackburn's "*Manual of Autopsies*" Designed for the Use of Hospitals for the Insane, 1892:

"The section is sometimes slightly modified from the original plan of Meynert; it may be made as follows:

"The brain is placed with its base upward and the cerebellar end toward the operator. The cerebellum is lifted up and the pia mater is cut through above the corpora quadrigemina, around the crura, and along the inner margins of the temporal lobes until the middle cerebral arteries are reached. The Sylvian fissures are now opened to their entire extent, the opercula are raised and the insular lobes exposed to their limiting furrows.

Fig. 19.—Frontal section of human brain, according to Pitres' plan.—(Blackburn).

"The apices of the temporal lobes are now raised, and with the knife held nearly horizontally, their junction with the base is cut through until the anterior extremities of the descending cornua are opened. The knife is now inserted into the descending horn, and the incision is carried backward as far as the posterior angle of the insula, or even some distance beyond it, severing some of the convolutions at the posterior extremity of the Sylvian fissure.

"The next incision is made to separate the basal piece from the posterior extremities of the frontal lobes. It connects the anterior boundaries of the islands, and opens the anterior horns of the ventricles. The incision may be a slightly curved, transverse one, connecting the anterior borders of the islands; or by a little care and a double-crescentic cut the exact boundaries of the convolutions may be followed.

"The cerebellum is now raised and the knife is entered at the posterior angle of the island, and the incision is carried along the outer limiting furrow until it meets the cut previously made through the anterior border. Care must be taken to keep the knife in the angle between the roof of the ventricle and the basal ganglia, to avoid injuring the latter. The basal piece is now lifted until the anterior crura of the fornix and the septum lucidum may be severed, and the basal section thereby completed (Fig. 20.).

"The basal piece thus separated includes the islands of Reil, the basal ganglia, the crura, pons, medulla, and cerebellum. The brain-mantle includes the convolutions, the corpus callosum and fornix, and the olfactory tracts.

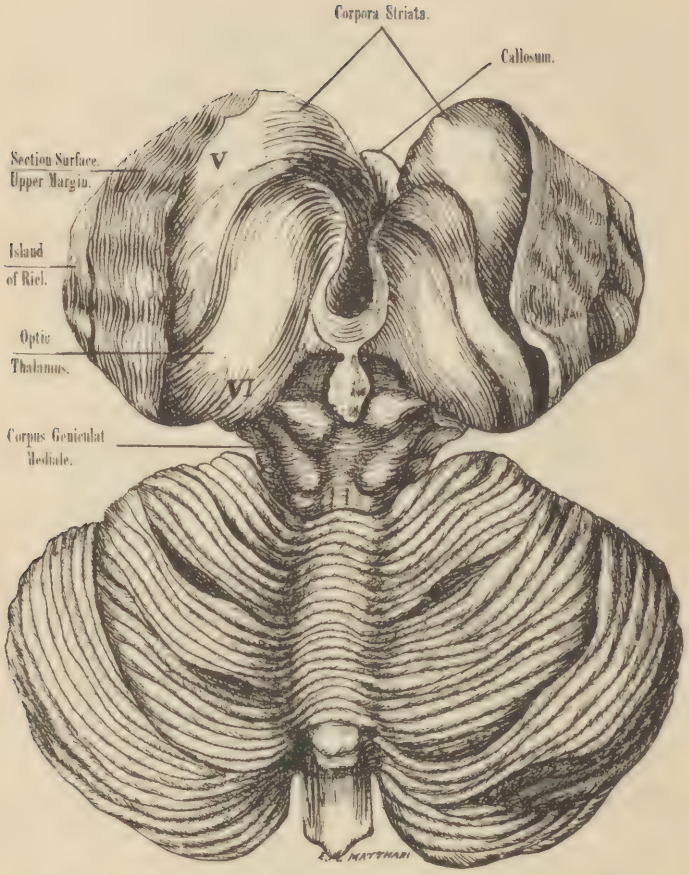

Fig. 20.—Brain axis and cerebellum separated from the brain mantle after Meynert's method.—(Siemerling).

The piece includes the islands of Riel, the basal ganglia, the crura, the pons, the medulla, and the cerebellum.

"The cerebellum may be separated from the brain-axis by cutting through its peduncles, and the lobes may be incised as in other methods. The basal ganglia, pons, and medulla are best examined by transverse incisions. The brain-mantle may be incised, if desired, by Pitres' method, or hardened without further section."

THE BASE OF THE SKULL.

The sinuses at the base of the skull are opened in situ with a knife or scissors and their interior closely examined. Special attention is to be given the transverse, the cavernous, and the petrosal sinuses on account of their liability to show changes secondary to middle ear disease or mastoid necrosis.

The hypophysis cerebri (pituitary body) is carefully dissected out of the sella turcica after a sufficient circular incision has been made into the dura. The dura lining the fossæ of the base is now torn away from the bones by means of dissecting forceps and the fingers. The removal of the dura permits ready differentiation between actual fractures and misleading furrows and suture lines upon the floor of the cranium.

In cases of meningitis the processes of the dura that extend into the various foramina and canals and in this way communicate with extra-dural cavities must be carefully examined. All the adjacent cavities, the ear and the mastoid cells, the frontal, the ethmoid and the sphenoid sinuses, the orbits and the nose must also be inspected for primary disease foci. The sinuses may be opened by simply chiselling away their roofs, or

they can be examined in the course of the more elaborate proceedings about to be detailed.

THE ORBITS.

The roof of the orbit can be chiselled away very easily on account of its extreme thinness and its contents thoroughly examined without any anterior deformity; the posterior half of the globe of the eye can be cut away with the scissors and the interesting changes in the choroid and retina observed in many diseases can be studied nicely and at leisure; the anterior portion of the eye can be kept in place by plugging the orbit with cotton. When there is no objection on account of cosmetic reasons the eyeball can of course be enucleated through the palpebral fissure.

THE EARS.

The easiest method of removing the ear in toto consists in loosening the whole petrous portion by two saw cuts which meet at its apex; the external ear, surrounding scalp and muscles are first dissected away from the bone and externally the saw cuts diverge sufficiently to include the mastoid cells (Fig. 21). The ear can now be dissected at leisure according to any of the methods described for this purpose in special works (Politzer), a ready way being to place the mass in a vise and saw it clear through from the posterior border of the external to the anterior border of the internal auditory canal. The ear can be examined well in loco by carefully chiselling away the roof of the tympanum, going back sufficiently to open the mastoid cells.

Fig. 21.—The floor of the skull. The black lines indicate the saw-cuts to be made in order to remove the ear and to expose the naso-pharynx. The black dote on each side of the crista galli represent the drill openings into which the key-whole saw is inserted. (Modified after Nauwerck.)

THE NASAL CAVITY.

In order to examine the nasal cavity the ethmoid bone and attached parts are to be removed by means of saw cuts through the bone on either side, commencing in the foramen magnum and extending forward into the frontal bone, the bone between the anterior ends of the two saw tracks being cut across. These cuts are best made with a so-called keyhole saw. The mass is then grasped with bone forceps and twisted loose, the soft parts being severed with a knife.

Should only the anterior nares be examined, this is readily accomplished by separating the upper lip from the bone and then severing the cartilaginous septum, removing as much thereof as required.

In some cases it may be deemed advisable to remove the organs of hearing in connection with the naso-pharynx; then two vertical drill holes are to be made, one in each frontal fossa, 1 *cm.* to the right and to the left of the crista galli, passing through the nasal cavity and through the hard palate; a narrow key-hole, saw is then passed through the right of these canals and an incision is made backward through the anterior fossa to the middle of the posterior margin of the lesser wing of the sphenoid; from this point the incision is continued through the middle fossa in the shape of a curve with the convexity outward so as to cut through the greater sphenoidal wing, the squamous portion of the temporal including the glenoid fossa and the temporo-maxillary articulation, through the middle of the

bony auditory canal to a point which corresponds to the junction of the petrosal and transverse sinuses, whence the incision is continued onward and forward through the jugular foramen, through the basilar process, describing the same curve through the left middle and anterior fossæ as through the right, stopping at the drill hole to the left of the crista galli which is then united with the one on the right by means of a transverse cut (Fig. 21). This mass is now loosened by means of a broad chisel, and as it is lifted up with a forceps grasping the sella turcica, a strong, sharp scalpel divides the posterior and lateral walls of the pharynx, the capsules of the temporo-maxillary joints and all other muscular and fibrous connections.

In order to expose to view the upper air passages (nasal, pharyngeal, laryngeal and accessory cavities) Harke* recommends the following ready procedure:

After removing the brain in the ordinary manner, the soft parts are reflected anteriorly down to the root of the nose, posteriorly down below the foramen magnum. Then the floor of skull is divided in the median line by means of a keyhole saw from the nasal bones in front to the occipital foramen behind, keeping as nearly as possible in the median line. Now the two skull halves are separated by means of a broad chisel and a mallet, and as the nasal and pharyngeal cavities come into view, the pieces of mucous membrane may be cut across with the knife or scissors so as to prevent further tearing. With the hammer and the chisel the

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* *Berliner Kl. Wochenschrift*, 1892, No. 30.

axis may be divided. The two halves of the skull are still connected by the nasal bones, the maxillary process of the upper jaw and the bony palate; strong traction will separate these bony connections without injury to the soft parts and the lateral halves of the skull and spine will yield sufficiently to permit inspection of the tract clear down to the vocal cords. Usually the median incision passes a little to one side, but the partitions between the accessory cavities are readily cut away with strong scissors; the maxillary sinuses as well as the frontal, sphenoid and ethmoid cavities are also easily opened from the median surfaces.

THE FACE.

The ends of the transverse incision over the head may be prolonged down upon the neck and then the external ear and skin may be dissected loose in a forward direction so as to expose the parotid regions. In order to examine the anterior portions of the nasal cavities the upper lip may be loosened from the bones. In cases of fractures, injuries and diseases of the bones of the face the mode of examination will vary much, depending upon the nature of the case. Removal of the larynx, pharynx and tongue from below (soon to be described) will greatly facilitate correct observations of lesions of various kinds about the face and the adjacent cavities.

THE LONG ANTERIOR INCISION.

The body lies on the back and the head should hang over the end of the table so as to bring the neck well forward. The physician should stand to the right

of the body, and grasping the section knife firmly in the hand, a long incision is made in the median line from the chin to the pubes, passing in a gentle curve to the left of the navel so as to leave the round ligament of the liver intact. This incision is best made with the whole edge of the section knife, which is held as nearly horizontally as possible, as the whole length of the primary incision is made with one continuous stroke. In emaciated bodies the larynx is very prominent and care must be used not to wound it while dividing the attenuated cutaneous covering. In many instances it may become necessary to begin the incision at some point below the chin in order that no external disfigurement of the body shall be visible or conspicuous (Fig. 22).

The deep depression above the top of the sternum is readily obliterated by putting the skin on the stretch between the thumb and index-finger of the left hand, so as to avoid using the point of the knife.

The soft covering of the thorax is at once cut through to the bone while over the abdomen the primary incision only extends into the muscular layers of the wall; in men the lower end of the incision terminates at the root of the penis; in women near the anterior commissure.

An opening is now carefully made into the abdominal cavity, just below the ensiform cartilage; two fingers are then introduced into the cavity which lift the anterior wall well away from the intestines and as the fingers are spread apart, the volar surfaces pointing towards the pelvis, the tissues are divided between them

down to and upon the pubic symphysis; or the margin on the right side of the incision into the cavity may be grasped with the left hand which in this way brings the wall away from the viscera while the division is completed down to the symphysis.

In order to turn the abdominal walls more readily away to the side the recti muscles may be divided subcutaneously near their attachment to the pubes; in this way more room is obtained (Fig. 22).

Fig. 22.—The long anterior incision.

On opening the peritoneum the escape of gas or of fluid should be noted, and the latter, if possible, collected at once in order that the total quantity may be accurately measured, if so desired. Should the abdominal cavity contain an excessively large amount of free fluid, then it may be best for reasons of cleanliness as well as for other purposes, to bail out a con-

siderable quantity immediately after making a small opening into the peritoneum.

The abdominal wall is now drawn outward over the costal arch with the left hand and then a long cut is made through the peritoneum and the attachment of the abdominal muscles to the margins of ribs from the xiphoid process out to the eleventh rib. The anterior attachments of the thoracic muscles to the sternum are then divided by vertical incisions: the left hand grasps the layer of soft tissue, the fingers resting on the external, the thumb on the internal surface, and as the soft covering is pulled away from the thoracic cage, the deep tissue is divided in long, sweeping incisions that pass from below upward and outward. The soft parts are dissected in this manner on both sides beyond the costo-chondral junction.

If it is desired to examine the mammary glands from the posterior surfaces or to expose the ribs, then the soft parts may be dissected loose far beyond this line. In the neck the platysma myoides is to be dissected off in connection with the skin so as to expose the greatest extent that one is allowed for cosmetic reasons, of the larynx, the sterno-cleido-mastoid muscles and the regions about the sterno-clavicular articulations.

It is now in order to carefully examine the soft parts that have been exposed; the amount and the condition of subcutaneous adipose tissue can be accurately ascertained; the thoracic and abdominal muscles are also to be carefully scrutinized, and lastly the mammary glands may, if occasion require it, be laid open and examined from behind.

INSPECTION OF ABDOMEN.

A general inspection of the abdominal cavity should be made at this time in order to avoid any possible change in the position of the organs or mixture of fluids that might ensue as a consequence of opening the thoracic cavities. The color of the exposed organs should also be determined immediately after opening abdomen.

In medico-legal cases when the cause of death is strongly suspected to exist within the abdomen it is customary to examine the abdominal organs first: in such instances the general order of procedure to be described later on may be followed with such modifications as are necessary in consequence of the special conditions in the individual case.

Inspection of the abdominal cavity includes thorough investigation in regard to the position of the various organs, the color and conditions of the peritoneal surfaces, the contents of the cavity, abnormal adhesions, etc.

The position of the liver and the stomach should be carefully noted at this time, because of their tendency to alter their position during the progress of the autopsy. The various forms of hernia and other intestinal malpositions are to be minutely looked for, especially when symptoms of intestinal obstruction were present during life. The omentum is to be raised up and folded over the lower thoracic wall so that the small intestine can be inspected from all points of view; for this purpose it must also be raised out of the pelvis

as well as in order that abnormal contents may be seen, as they have a tendency, if fluid, to accumulate in the depressions of the peritoneal cavity such as the pelvic and the regions about the kidneys.

The quantity, color, consistence and nature of the abnormal contents should be determined at this time; if for any reason intestinal perforation may be thought to exist, then the whole gastro-intestinal canal should be minutely examined until it is definitely settled whether perforation has occurred or not.

In women inspection of the pelvis takes note of the size and shape of the uterus, the condition of the broad ligaments and the ovaries.

The particular regions in the abdomen in which old adhesions are most frequently encountered are the pelvic cavity in women, the ilio-cæcal region, where they are usually connected with the vermiform appendix, about the gall bladder and around the spleen.

In separating old or recent peritoneal adhesions great care should be exercised not to exert such traction upon the perhaps distended and weakened intestine as to produce rupture and extravasation of possibly large quantities of fluid fecal matter.

Finally the position of the diaphragm is determined by inserting the fingers of the right hand first under one and then under the other costal arch up to its highest point (on the right side outside the falciform ligament), and then by pressing the fingers against the chest wall the exact height of the midriff can be made out with reference either to a rib or interspace. The same point should be selected on each side, as, for

instance, the junction of the cartilages with the ribs, in order that the comparison may be a legitimate one. In this way information may be obtained with reference to the condition of the thoracic cavities as regards their degree of distension.

OPENING THE CHEST.

The costal cartilages are divided as near their junction with the ribs as possible with a heavy knife which is held parallel with the surface, so as to avoid cutting the heart or the lungs; the division commences with the second rib and extends downward and outward in a line with the costo-chondral insertion and by pressing on the back of the knife with the left hand the cartilages are readily and continuously cut across without removing the knife except when calcification has taken place, and then the ribs should be divided by means of an ordinary saw just beyond the chondral insertion (Fig. 22).

In cases of suspected pneumothorax a small pocket should be made in the soft parts over an intercostal space and this may be filled with water; on puncturing the pleura the gas will bubble through the water.

The portion of the diaphragm between the lines dividing the costal cartilages is now severed immediately underneath the ensiform cartilage and the false ribs, and the sternum, lifted forcibly up, is rapidly separated from the tissues of the anterior mediastinum, (great caution being used not to injure the subjacent structures), clear up to the sternoclavicular articulations.

The sterno-clavicular joints are best disarticulated in the following manner, because then the large vessels are least liable to injury: Lift the sternum up and draw it quite forcibly to the right with the left hand; now cut the cartilage of the first rib from below upward; incise the structures over the left sterno-clavicular joint from below upward and backward also, the edge of the knife being directed up and backward; as the articular surfaces become exposed, the remaining ligaments are easily cut. By similar manipulation the right joint is separated and the whole sternum with the costal cartilages is placed to one side.

Too much force in lifting the breast bone up may fracture the manubrium near its junction with the middle piece.

Disarticulation of the clavicles by means of semilunar incisions with a thin knife, the convexity being directed inward, is liable to damage the large vessels and lead to the confusing presence of blood in the pleural cavities, unless made with great care and expertness. By grasping the clavicle and moving it the exact location of the sterno-clavicular joints can be determined.

INSPECTION OF THE CHEST CAVITIES.

After removal of the sternum the amount of distension and the general appearance of the lungs as to color should be noted.

The natural tendency of healthy lungs to collapse almost immediately after opening the chest may be overcome in a variety of ways, as, for instance, by fibrous pleuritic adhesions, by the filling of the alveoli

with solid or fluid substances, by laryngeal and other obstructions which prevent the escape of the air.

The pleural cavities are to be examined for abnormal contents, the character and the amount of which are carefully noted. Pleuritic adhesions which either partly or completely obliterate the cavities are also taken note of at this time, but the separation of tough and quite extensive adhesions must be postponed until the time for the removal of the lungs.

The mediastinum is also to be examined in a general way at this time; the thymus gland should be looked for because it may persist long after the usual time for its complete disappearance. The condition of the great vessels in the mediastinum must be ascertained as far as that is possible by means of external palpation so that the presence of aneurisms or other abnormal conditions does not escape notice and become incised unawares on removing the heart.

THE PERICARDIUM.

In order to open the pericardium a small incision is made in the centre of the anterior surface, a small fold being first pinched up in order to prevent injury to the heart; through this incision two fingers of the left hand are introduced which lift the pericardium away from the heart as the incision is prolonged first downward to the left, then downward to the right, and then upward as far as the point of reflection of the pericardium upon the large vessels.

The escape of fluid through this incision must be guarded against by removing the excess while the

incision is still limited. The contents of the pericardium are to be examined with reference to quantity and to nature. The surface of the pericardial layers which normally is smooth and shining, is also to be inspected for minute as well as extensive changes, such as inflammatory exudates, circumscribed thickenings and opacities, fibrous adhesions, subpericardial ecchymoses in death from suffocation, etc.

Should the cavity be completely obliterated by fibrous adhesions, then it will probably be best to remove the pericardium and the heart together without any attempt at separation, which is exceedingly liable to result in rupture of the thin auricular and right ventricular walls. It will consequently be best to make the necessary incisions into the heart through the pericardium and the heart-wall at the same time; in the case of firm, circumscribed adhesions the adherent parietal pericardium may be cut away from the rest of the membrane.

THE HEART.

There are a number of methods of examination of this important organ each of which may, if thoroughly understood, yield very satisfactory results. The principle involved in these various methods is quite the same, namely: each step in the procedure must not in any way interfere with the parts of the heart that may remain to be examined.

The external examination of this organ can be largely completed while it is still in situ and before any incision is made into any of its compartments.

The position of the organ in general, and of the apex in particular, should be noted whenever there is any change in this respect; it may be measured in its greatest transverse diameter as well as from base to apex; the form can readily be studied; normally the apex is formed by the left ventricle alone and when the right ventricle participates in its formation, an enlargement is present on the right side of the heart.

The consistency of the various portions depends on the degree of muscular contraction and on the amount and the condition of the contents; simple contraction may completely obliterate the cavities while distending fluid contents always yield to pressure.

It is very important in medico-legal acses to carefully examine into the condition of the coronary vessels as they are observed with the heart in situ. The coronary arteries and veins are readily distinguished between on account of the difference in the thickness of their walls and in their course; a marked distension of the veins upon the anterior surface of the heart points to obstruction to the outflow from the right auricle and it is consequently usually observed in cases of death from asphyxia; distension of the coronary veins on the posterior surface alone is usually due to hypostasis. Arterio-sclerotic coronaries can often be recognized on account of their rigidity and the streaks of whitish or greyish-yellow color which mark their sinuous course.

It is quite customary to open the various compartments of the heart while it is still in situ in order to determine the amount and the condition of the blood

contained in each. Inasmuch as the fluid blood does not remain stationary after death either before or after opening the heart, as the clotted blood remains until after the removal of the heart, and as the condition of the cavities as regards the amount of blood contained in them can be quite as accurately determined by external examination, it becomes somewhat difficult to understand the necessity of always opening the heart before its removal. However, the incisions for this purpose can be made in such fixed locations as to serve as the commencement of those employed in the more complete examination after removal, and in certain medico-legal cases of some of the various forms of asphyxia or in which the blood is to be retained for analysis, it may be well to estimate as closely as possible the amount of the blood in each cardiac cavity.

Place the left hand under the heart, draw it downward and to the left so as to bring the points where the superior and inferior vena cava enter the auricle plainly into view; make an incision into its cavity between these two points down to a little above the transverse furrow.

The right ventricle is then opened along its right border by an incision that commences immediately below the circular furrow and runs downward in line with the incision into the auricle, stopping short of the apex in order to avoid the interventricular septum; now place the knife to one side and remove the fluid blood and the loose clots that may be present in the two cavities of the right heart; the size of the tricuspid orifice may be estimated at the same time by

inserting the fingers of the right hand through from auricle into ventricle; ordinarily the orifice admits four fingers.

In order to incise the cavities on the left side the heart is grasped so that the fingers of the left hand lie upon the anterior surface and the thumb on the posterior, the apex resting in the hollow of the palm; the organ is then drawn to the right at the same time as pressure with the thumb near the septum makes the left ventricle bulge out somewhat prominently. Then make an incision from the left superior pulmonary vein through the auricular wall nearly down to the transverse furrow; then the cavity of the left ventricle is opened at once by an incision which commences below the transverse furrow and extends along the left margin down to the apex.

The knife is again placed to one side and the contents removed from the cavities now opened; the diameter of the mitral orifice may be estimated in the same way as the tricuspid; ordinarily it admits two or three finger tips, depending, of course, somewhat on the size of the fingers. Firm rigor mortis of the ventricle may contract the orifice somewhat and then the rigidity must be carefully overcome by spreading the fingers apart.

At this time no effort should be made at palpation of the free valve margins on account of the danger of removing vegetations and thrombotic masses. This method of estimating the diameters of the orifices is not nearly so satisfactory nor precise as the use of

graduated cones and, if they are at hand, then it is not advisable to insert the fingers as detailed.

In making the four incisions referred to, the large coronary branches should be avoided as much as possible, and in the districts cut across at this time but few of these vessels occur as a rule.

In all cases of sudden death it is well to open

Fig. 23. Removing the heart after having opened and emptied the cavities.

the pulmonary artery in situ in order to determine the absence or presence of emboli.

The heart is now removed in the following way: insert the left thumb into the right and the forefinger into the left ventricle, draw the heart directly upward and cut successively the vessels that enter and leave it as near the pericardium as possible (Fig. 23).

In the routine examination the next step consists in testing the competency of the semilunar valves with water; for this purpose all coagula are extracted from the orifices and while the heart is held by the auricles so that the plane of the orifice is horizontal—in this way distortion is avoided and the valves are not given unnatural support from below—a column of water is poured into the aorta or pulmonary artery as the case may be;* these vessels should be trimmed down so that the behavior of the semilunar valves can be readily observed through the column of water poured in to test their competency: in case any of the large coronary branches have been cut across enough water may trickle away to throw doubt upon the integrity of the valves unless they are seen from above to meet exactly andperfectly.

*"The substitution of air for water will be found a great improvement on the water method, as it may be utilized for all the valves, and can be made to display the action of the cusps in motion. The following is the manner of adapting it to the various orifices.

"An incision is first made into the left auricle and any post-mortem clots are carefully removed from the left chambers through it. Another incision large enough to admit the nozzle of a half-inch tube is made into the ventricle near its apex and in the line of that required for laying it fully open. The tube is joined to a bellows and air is driven intermittently into the ventricle by means of it, the aorta having been meanwhile closed. The valve will be seen to open and close, according as the air is aspirated or driven out of the bellows. A like procedure is adopted for the demonstration of the tricuspid. To test the aortic valve, the incision before described as necessary to open the left ventricle is continued up as close to the valve as possible without injuring it. The tube is tied into the aorta, and the action of the valve is watched from below. The same method is used to test the competency of the pulmonary artery valve."—(Hamilton).

The heart can now be opened completely by passing the blunt end of a properly constructed enterotome (Fig. 24) into the right ventricle above the attachment of the papillary muscle to the anterior wall and then cutting through the wall as far to the left as possible, stopping below the pulmonary ring, if its circumference is to be measured with a graduated cone, otherwise the incision is continued into the pulmonary artery (Fig. 25).

The reason that the papillary muscle attached to the anterior wall of the right ventricle should not be cut is mainly this, that after the muscle has been

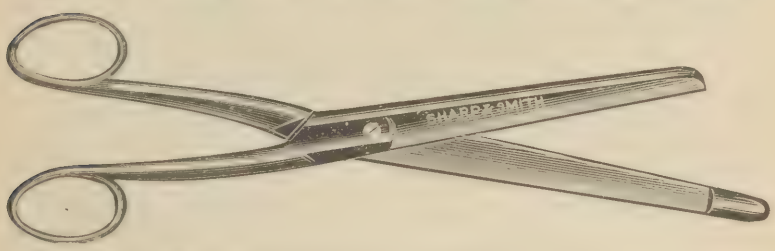

Fig. 24.—Enterotome with smooth, blunt projection.

severed the tricuspid orifice dilates somewhat on account of relaxation of the valvular structures and hence any measurements after cutting across the muscular mass referred to would not be entirely reliable.

If the scissors are held as far as possible to the left the division will pass between two of two pulmonary valve segments without injury to either (Fig. 26).

Open the left ventricle in somewhat the same manner by passing the enterotome upward into the ventricle from the incision already made, then cut along the interventricular septum, then between the pulmon-

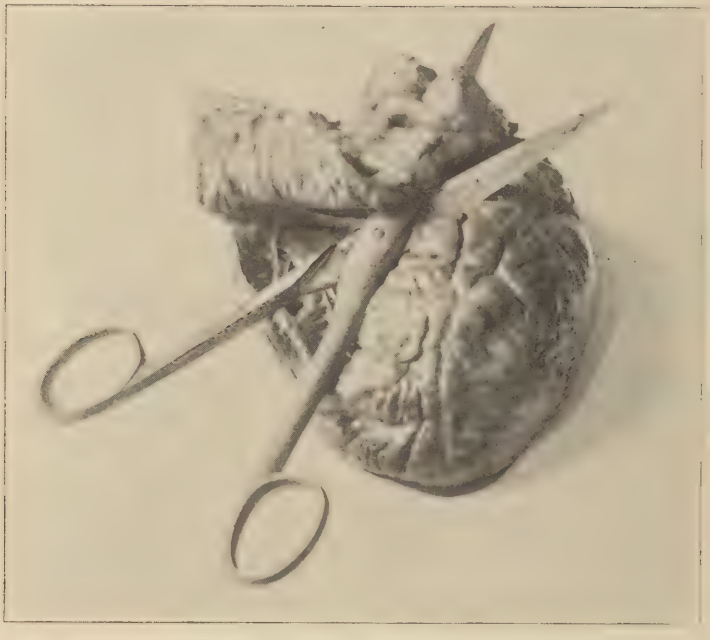

Fig. 25.—Opening the right ventricle of the heart.

The blunt blade passes above the papillary muscle and out through the pulmonary artery.

Fig. 26.—Opening the heart.

The right ventricle has been opened by completing the incision commenced in Fig. 25; the interior shows the papillary muscle attached to the anterior wall and the intact pulmonary valves.

The left ventricle is being opened, the blunt blade of the enterotome projecting out from the aorta as the incision is made between the pulmonary artery and the left auricle.

ary artery and the auricle, through the aorta; one of the segments of the aortic valves is unavoidably cut in two by this incision (Fig. 27).

If the graduated cones are used (Fig. 28), then these incisions into the ventricles are only partially completed, the orifices being left intact. All the orifices, the aortic, mitral, pulmonary and tricuspid, are first measured by pushing the cone carefully through the opening in the direction of the blood current until it is

Fig. 28.—Graduated wooden cone for measuring the diameter of orifices.

felt to be arrested; after this the incisions just described may be continued through the orifices so that the ventricles are laid wide open.

The auricles may be opened still more than was done while the heart remained in situ by prolonging those incisions out through veins on each side. In this way a good view may be obtained of the auricular

Fig. 27.—Opening the heart.

The left ventricle laid open as indicated in Fig. 26. The aortic valves are the seat of acute ulcerative endocarditis. The anterior coronary segment has been divided in two.

aspect of the mitral and tricuspid valves. Finally, if it is desirable, the original incisions into the auricles and the ventricles on each side may be united by a cut which divides the mitral and tricuspid rings.

In the ordinary clinical case it may not be considered necessary to open the heart in situ and it is removed after a careful external examination by cutting off the vessels as far away from the organ as possible, as the left hand lifts it upward and out of the chest. It should be placed immediately on a plate so that the blood does not drip upon the body and its surroundings. The heart cavities can be opened after a still more complete external examination.

The auricles may be laid widely open by incisions, which in the right runs from the mouth of the superior to that of the inferior vena cava, in the left between the orifices of the pulmonary veins; all blood clots can now be cleared out from these compartments.

Now place the heart on a smooth surface with the posterior aspect downward, and the apex toward the examiner, make a small opening into each ventricle near the apex with the enterotome; prolong this incision upward along the septum on both sides and also along the right and left margins of each respective ventricle, but stop short of the various cardiac orifices; the ventricles are now emptied of blood clots, the competency of the semilunar valves are tested with water in the same way as already described and the diameter of the orifices measured with the graduated cone.

After this the ventricles may be incised completely by carrying the incision (Fig. 26) into the right out

through the pulmonary artery; and the one in the left out through the aorta; finally the auriculo-ventricular valve rings may be divided by an incision uniting the cuts into ventricle and auricle on each side.

All these incisions can be made with an enterotome, the blunt end of which must be perfectly smooth and not hooked, otherwise it becomes caught in the papillary muscles and chordæ tendineæ of the ventricles. With a little practice and caution the heart can be readily laid open with a suitable knife also, in the manner above indicated.

It will be observed that the heart removed without opening any of its cavities should present very nearly, if not exactly, the same appearance as to incisions, while the same observations have been taken, as when the partial openings made while the heart was still in situ, were completed after its removal from the body.

We are now in position to make a detailed examination of all parts of the heart and for the sake of completeness this should follow some fairly definite order. Commencing with the aortic valves the valvular and the mural endocardium may be studied first in the left and then in the right side of the heart, careful notes being made of whatever pathologic conditions are found. Then the size of the ventricles both as to the wall thickness and the depth of the cavities must be measured; the depth is measured from the base of the semilunars down to the apex of the ventricles. The auricles can also be measured as to the thickness of their walls and their size may be estimated in a general way. While these measurements give a fairly accurate idea as to

condition of the heart with reference to atrophy or hypertrophy, yet the weight of the organ affords the most accurate indication of absolute increase or diminution.

The shape of the ventricles and the condition of the papillary muscles must be noted in hypertrophied hearts.

The myocardium should be carefully examined as regards the color, the consistence and the special morbid conditions, but before any new incisions are made through the muscular tissue the coronary arteries must be subjected to a careful examination which begins with and includes the commencement of the aorta because the coronary orifices may be seriously involved in the sclerotic changes so often found immediately above the aortic valves. In all cases of sudden death from obscure causes the condition of the coronary vessels must be watchfully studied for the changes embraced under the term arterio-sclerosis and their consequences; for this purpose the coronaries are incised with a small, sharp scissors from their beginning upon the aorta out to the minutest ramifications that can be laid open; in the case of doubtful instances of coronary disease and secondary myocardial changes microscopic examination may show astonishingly extensive lesions.

Variations in the origin of the coronary arteries are common; they may have a common orifice, they may both arise from the same sinus of Valsalva, or, a third coronary may arise from the pulmonary.

In order to obtain extensive cut surfaces of the myocardium further incisions may be made into it, either vertical or paralel to the surface of the heart;

thus the wall of the left ventricle can usually be nicely divided into an outer and an inner half which present comprehensive views of the cut surface; the interventricular septum may be divided by a vertical incision.

As the various steps in the routine examination of the heart are essentially the same whether the organ is removed before any incisions are made into its compartments or not, the following enumeration may be in order:

1. External examination.
2. Preliminary incision into auricles and ventricles and removal of contents.
3. Water test of semilunar valves.
4. Measure orifices with graduated cones or fingers.
5. Open ventricles and auricles fully.
6. Examine endocardium systematically.
7. Measure thickness and depth of ventricles.
8. Weigh the heart.
9. Examine the commencement of the aorta and the coronary arteries.
10. Expose the myocardium by free incisions.

The general principles that form the foundation of this routine method of examination of the heart may be summarily stated as follows:

1. The preliminary incisions are necessary in order to empty the cardiac cavities and to make it possible to apply the water test to the semilunar valves.
2. The preliminary incisions must avoid all valvular orifices because their size must be determined with the cone or the fingers; they must also avoid the large

coronary branches in order that the water test of the aortic semilunars may be as positive and decisive as possible.

3. The preliminary incisions are therefore to be made in certain fixed locations, not alone for the above reasons but also in order that they may serve as the commencement of the incisions that lay the cavities widely open. Consequently the left auricle is incised from the mouth of one pulmonary vein to the other, the left ventricle along the left border to the apex and then upward along the septum; the right auricle is incised from one vena cava to the other, and the right ventricle along its right border and then upward to the right of the septum, avoiding the papillary muscle upon the anterior wall.

4. After having tested the semilunar valves and measured the orifices, the heart cavities are completely opened by uniting the incisions into the auricles and ventricles on each side and by continuing the incisions near the septum out through the pulmonary artery and the aorta (Fig. 26).

THE PLEURA AND THE LUNGS.

Adhesions between the lungs and the chest wall as well as the pericardium must be loosened first on one side and then on the other. Should it be found that the adhesions are so firm that there is liability of tearing the pulmonary parenchyma in order to separate them, then the parietal pleura must be removed at the same time as the lung. For this purpose the costal pleura is incised parallel with the costo-chondral junc-

tion, and then the index-finger of the right hand works itself in between the pleura and the chest wall in an intercostal space; by traction and by a side-to-side movement the whole hand may be gradually introduced, which then completes the separation: at the apex it may be necessary to cut across with the knife the dense cicatricial masses sometimes encountered.

In order to separate the costal pleura on the right side in this manner it is necessary for the operator to stand on the left side of the body for the time being; to protect the back of the hand against scratches from the cut cartilages it is well to fold the soft covering of the chest wall over the cartilages.

Detachment of the parietal pleura in this way in the case of old empyemas often yields instructive specimens, as the abscess can then be removed in connection with the lung.

Inseparable adhesions between the lung and the diaphragm or the pericardium will necessitate the adherent portions of these structures being cut loose and removed with the lung.

After completely separating all adhesions that may exist, the lungs are removed by cutting across the bronchi and the vessels at the root of each, being careful not to wound the aorta or the esophagus.

After the removal of the lungs the pulmonary pleura is again subjected to a careful and systematic examination which has in view the detection of minute as well as more extensive lesions of various kinds, such as pleuritis, tuberculosis, circumscribed necrosis, changes in the lymphatic vessels, etc.

Then the various lobes of the lungs are studied with particular reference to deviations in size, weight, color, degree of distension with air, and consistency.

Each lung should be weighed separately.

Various conditions of the pulmonary parenchyma may be recognized externally by their color, as, for instance, the bluish-red areas of atelectasis in bronchopneumonia.

By palpation considerable definite information may be gained as to the amount of air present in the lungs; the soft crepitation of the normal lung substance is absent in the firm, solid, distended lung of lobar pneumonia as well as in the condensed lung of atelectasis.

Inflation of the lung by means of a blow-pipe inserted in a bronchus will show whether distension is possible or not in certain lungs; inflation will also demonstrate well the characteristic appearance of distension in emphysematous lung tissue as well as the opening in the pleura in pneumo-thorax. Palpation will also indicate the presence of cavities over which fluctuation may be felt.

In order to incise the lungs each must be placed "on its diaphragmatic surface, the root being so grasped in the left hand that the primary bronchus lies in the fork between the thumb and forefinger;" an incision is then made from the apex to the base along the convex border so as to expose the largest possible extent of cut surface; this incision should pass through the center of the root so that the large vessels and bronchi may be laid open at the same time.

Or the lung may be placed with the hilus and base against the table, and while it is supported in this position by means of the left hand, the fingers of which are spread out upon the surface of both upper and lower lobes, an incision is made clear through to the root extending from top to bottom. This incision should be made with one stroke of a long, sharp knife, and it cannot be regarded as correctly made if the bronchi that go to the upper and lower lobes are cut off from the main bronchus (Fig. 29).

The middle right lobe should be laid open with an independent incision through its greatest diameter.

These lung incisions are readily made when the organ remains distended on account of abnormal substances in the alveoli, as in lobar pneumonia, but it is rather difficult to make a satisfactory cut into collapsed, spongy, healthy lung parenchyma unless a very sharp knife is used.

Gentle compression of the lung will demonstrate the condition of the parenchyma in the various parts as regards the presence of air, of edematous fluid, of blood, etc. The color of the cut surface should be noted. In the various pneumonias casts may be scraped from the surface and in pulmonary tuberculosis the generous display of cut surface will aid one much in locating the lesions and in distinguishing between the different varieties. Absolutely solid pieces of lung tissue sink in water.

There are a number of circumscribed lesions, however, that might escape detection if only one large incision were made; consequently the bronchi must be

Fig. 29.—The main incision in the lung.

The right lung has been divided by a long incision which has opened the main bronchial and vascular branches longitudinally.

opened by means of small probe-pointed scissors out into their smallest branches, as much of the lung tissue being included between the blades as possible; frequently a grooved director inserted into a bronchus will be of aid in incising the overlying tissue, which should always be done with probe-pointed, sharp scissors, boring and violent twisting being avoided. In this way bronchiectasia, vomicæ, peribronchitic areas, caseous and calcareous foci, slaty areas, and a number of other small, local lesions may be discovered at the same time that the condition of the bronchial mucous membrane is ascertained.

The pulmonary vessels are also to be laid open with probe-pointed scissors so as to expose the intima, and demonstrate the absence and presence of thrombosis or embolism.

In cases of death following extensive fractures or crushing and laceration of the soft tissues the lung parenchyma should be examined microscopically for capillary fat embolism.

The bronchial glands are divided with a knife, and in case they are found in advanced tuberculosis the condition of the adjacent vascular and bronchial wall must be carefully examined for extension of the process by continuity and contiguity of tissue, because thus they might become the point of origin of pulmonary or acute general miliary tuberculosis.

Now that the lungs have been removed there is abundant opportunity to examine the costal pleura and the ribs, especially their posterior portions.

THE NECK AND ITS ORGANS.

The larynx and pharynx must be carefully examined in all cases of sudden death from unknown causes.

In medico-legal cases an exceedingly painstaking and thorough examination of all the structures in the neck may become necessary, especially when death is suspected to have resulted from drowning or strangulation or when suspicious marks are observed during the external inspection. This dissection may be done either before or after the removal of the sternum and the lungs, but preferably afterward.

In purely clinical cases the extent of the examination of the neck and the mouth will vary considerably, depending largely on the peculiarities of the individual cases and the special object in view at the time.

The larynx and trachea may be opened from the front and their contents and mucous membrane inspected; from the larynx the finger may be passed into the pharynx and any large foreign or loose bodies can then be readily felt.

When important changes or injuries are suspected, or when a thorough examination is necessary for any purpose whatsoever, then the trachea, larynx and other organs in the neck as well as those in the mouth should be removed together and examined afterward. In that case it is undoubtedly best to examine the great vessels and the nerve trunks first because of the disturbance and probable injury during the removal of the larynx and other organs.

First the skin is to be carefully dissected loose on each side, so that the mandible is visible out to

the angles, the median incision extending to the symphysis menti; on the neck the sterno-cleido-mastoid muscles are exposed. The large vessels can now be isolated throughout their entire extent, they can be laid open in order to determine the condition of the intima which may be ruptured in cases of hanging and strangulation by other methods. The internal jugular vein may be the seat of thrombo-phlebitis, the primary cause of which might be ear suppuration.

At the same time the deep muscles and other structures can be examined for bruises and blood extravasation. At this time the nerves may be dissected out also. It will be recollected that the vagus usually lies between and behind the carotid artery and the jugular vein.

In order to isolate the sympathetic the carotid is drawn outward with a hook and the areolar tissue behind it is separated; the nerve lies upon the muscles covering the anterior surface of the cervical vertebræ and it can be followed upward and downward until all the ganglia have been found. The superior cervical sympathetic ganglion lies upon or near the transverse processes of the second and third vertebræ behind the carotid and the vagus; the middle ganglion, which is often missing, is usually placed opposite the fifth cervical vertebra. The inferior ganglion rests upon the head of the first rib or the transverse process of the seventh cervical vertebra, covered by the subclavian artery.

The vertebral artery may be exposed by removing with bone forceps the portions of the transverse processes, outside of the foramina they contain, of the six

upper cervical vertebræ; the course of the vessel as it ascends through the foramina is then readily followed.

After completing as much of the dissection as may be necessary at this time the organs of the neck and the mouth may be removed in the following manner: pass a knife into the mouth from below at the right or left angle of the jaw along the inner surface of the bone; cut around to the opposite angle in close apposition to the bone; at the chin some care must be used so as to prevent piercing of the tongue tip.

The fingers of the left hand can now be introduced into the mouth and the tongue can be pulled downward at the same time as the knife divides the attachments of the soft to the hard palate, and the posterior pharyngeal wall coming forward on each side so as to include the tonsils. It is perhaps best to divide the posterior pharyngeal wall below Luschka's tonsil because in the effort to go above it this lymphoid mass, if large, may become damaged. Downward traction on the tongue will enable one to separate the retro-pharyngeal connective tissue by means of short cuts; the connections between the œsophagus and the spine and deep cervical muscles yield very readily.

At the root of the neck the vessels going to the upper extremities are cut across on either side in a direction backward and outward, the left hand carrying the organs of the neck from right to left and back to the opposite side as occasion demands.

The separation of the gullet and the aorta from the vertebral column is easily accomplished by means of traction and the use of the knife; these structures may

be cut across above the diaphragm or the stomach may be removed in connection with the esophagus if so desired, as might be the instance in cases of poisoning or of malignant growths. In other cases the esophagus and the bronchi may be divided above the arch of the aorta and this vessel can then be removed in toto later on in the course of the examination.

The organs of the neck are to be placed so that the tip of the tongue points toward the pathologist, the esophagus lying uppermost.

The dorsum, tip and edges of the tongue are to be inspected, after which a number of transverse incisions may be made. Then the soft palate is divided to one side of the uvula, the pharyngeal mucous membrane is inspected while the tonsils may be incised if necessary.

The esophagus is then to be laid open by means of the enterotome along its left border and the general and special morbid conditions of its wall and lining membrane ascertained (Fig. 30).

The next step is the inspection of the larynx from above; particular attention is to be directed to the mucous membrane of the ary-epiglottic folds and the form of the glottis. Edema of the glottis may disappear almost completely after death, so that the mucous membrane may lie in folds and wrinkles instead of being smooth; this wrinkling is a sure sign of antemortem edema which only occasionally may remain quite marked after death.

The epiglottis is normally but very little curved from side to side; in all instances of fatal suffocation it assumes the suffocative position, by which is meant a

more or less marked approximation of its edges as compared with their normal position.

Small foreign bodies are not to be overlooked. The color and the degree of congestion of the mucosa are also to be carefully noted.

Fig. 30—The organs of the neck.

The soft palate has been divided to one side of the uvula and the esophagus along one border.

The larynx and the trachea are to be incised posteriorly along the middle line because here the cartilaginous rings are incomplete; as this incision is made the cut esophageal margin is drawn to one side so as to avoid subdividing the esophagus; by means of the fingers the laryngeal wall can be spread apart so that

full view is obtained of the interior of the larynx which can then (Fig. 30) be thoroughly examined, bearing in mind what has just been said with reference to the epiglottis and to foreign bodies.

On account of the extreme delicacy of the lining epithelium of the larynx great care must be exercised

Fig. 31.—The organs of the neck.

The œsophagus has been drawn to the side and the larynx opened along the median line posteriorly.

not to rub or scrape the mucous membrane over the districts that are selected for microscopic study.

The thyroid gland can be separated from its connections, weighed, and incised, and at the same time the form of the trachea can be noted.

The submaxillary glands, the cervical lymphatic glands, the deep muscles of the neck, and the upper

part of the vertebral column can be readily examined in various ways after the removal of the organs of the neck, and any special dissection may perhaps be carried on more readily at this time.

If the aorta was removed with the esophagus, then it is to be incised along its posterior wall.

REMOVAL OF ORGANS OF NECK AND CHEST IN TOTO.

In many instances of interesting intra-thoracic lesions it may seem advisable to remove the organs of the chest and the neck together in order that the relations of the various structures may be better preserved. Among the conditions that indicate such procedure may be mentioned aneurisms, tumors, congenital heart lesions or malformations, and many other infrequent and often during life obscure diseases.

The heart is to be opened in situ as usual; the lungs are to be fully loosened from all adhesions; the organs in the neck are to be dissected free in the manner above described, and then the large vessels on each side at the root of the neck are to be divided as they are put on the stretch by lifting each lung in turn toward the opposite side as far as possible; as traction is made upon the larynx and esophagus with the left hand the loose tissues between the spine and the aorta and the esophagus are readily divided by means of short cuts with the knife, and as the organs fall out of the thorax, separation clear down to the diaphragm is easily effected. The pericardial portion of the diaphragm may be cut away and the gullet and aorta severed as

they pass through this structure. Sometimes the stomach and the abdominal aorta are removed in conjunction with the contents of the chest.

The further dissection of the structures thus removed in toto will have to be made in accordance with the peculiarities of the special case.

In the case of aortic aneurisms and mediastinal tumors it is often desirable to trace the course of such nerves as the recurrent laryngeal in order to explain interesting pressure symptoms observed during life; in this instance the vagus should be isolated, before the removal of the organs, down to and below the place of origin of the recurrent laryngeal which can then be more readily traced in the specimen after the removal from the body. Similar plans may be followed with reference to other structures which it may be difficult to follow after their normal connections have been severed to a certain extent.

THE ABDOMINAL CAVITY.

The examination of the abdominal cavity and of its diversified contents often becomes a difficult problem, first on account of the close connection of the various organs, and secondly on account of the disturbance in their relations to each other in many of the morbid conditions encountered. Chronic peritonitic adhesions due to previous peritonitis, to carcinoma, or to tuberculosis, extensive pus accumulations of various kinds, complicated fecal fistulæ, intestinal distension due to gas and fluid, and many other conditions may be mentioned, all of which may embarass to a certain

degree the examination of the abdomen and modify the usual order of procedure.

The usual sequence in which the organs in the abdomen are removed is elaborated from the general rule, "that no organ should be removed, the absence of which would materially interfere with the subsequent examination of other organs."

In acute peritonitis no organ should be removed until the probable source of the inflammation has been made out, or until it becomes clear that the mode of origin can not be made out until certain organs are examined after their removal.

The following description of the technique of the examination of the abdominal organs takes up the individual structures in the order in which they are to be taken out and examined as a general rule.

OMENTUM.

The position of this structure is naturally first noted. It may be found to one side, doubled up, in a hernial sac, adherent or loose. In order to subject it to a scrutinizing examination it may be cut away from the transverse colon and spread out on a smooth surface. The omentum affords an excellent ready opportunity for the microscopic study of miliary tubercles, disseminated carcinosis, and inflammatory changes, because it is only required to excise a small piece from a portion that is free from fat and spread it out in any ordinary medium such as the physiologic salt solution.

THE PERITONEUM.

Considerable information has already been obtained in regard to this membrane from the general inspection of the abdominal cavity immediately after it was opened.

The peritoneum should, however, at this time again be scrutinized for evidences of recent and previous inflammation of different forms; certain regions, as already stated, are prone to lesions of this kind, such as the pelvis, about the vermiform appendix, about the gall bladder and the bile ducts, and the spleen, and in the routine examination these districts should always receive especial attention.

Chronic adhesions in any part of the peritoneum should always be inspected for tubercles and caseous masses.

In case abnormal contents are present, the cavity should now be thoroughly emptied and the total quantity measured or estimated.

THE SPLEEN.

This should be grasped with the left hand and drawn forward from its position behind the fundus of the stomach. Any adhesions to the diaphragm must be carefully separated so as to avoid tearing the splenic structure. As it is drawn forward the gastro-splenic omentum is brought into view and any gross changes in the splenic vessels, any accessory spleens or unusual conditions about the hilus can be readily noticed.

The organ is then removed by cutting across the vessels near the hilus; it should be weighed and meas-

ured; the outline and modifications of form, the color, thickness, tenseness, and smoothness of the capsule should be noted; an incision is made from the convexity to the hilus so as to divide it into equal halves, as many additional incisions being made in the same direction as may seem necessary. The color, the pulp, the follicles, and the trabeculæ can now be studied. The application of tests for amyloid material should not be neglected in suspicious cases.

THE ADRENALS AND THE KIDNEYS.

Each kidney and the corresponding adrenal are to be exposed and removed together. It is customary to begin with the left side.

The small intestine is to be brought out of the abdomen and left hanging over to the right side. The sigmoid meso-colon is divided near the intestine which is placed on the stretch with the left hand; the peritoneum to the outside of the descending colon and above the splenic flexure is incised and these portions of the large intestines are drawn over to the right, the retroperitoneal connective tissue yielding readily, and in this way the left kidney can be quite fully uncovered.

By lifting up the fundus of the stomach and the tail of the pancreas the left adrenal is also exposed.

The ureter can now be readily traced throughout its entire extent and the vessels that enter the hilus of the kidney can be isolated and accurately examined.

The kidney can be removed by separating it from its connective tissue investment with the hand and drawing it forcibly upward, the knife being used if necessary;

the vessels will yield to cautious traction or they may be cut across. The ureter may be allowed to remain connected with the pelvis in case this is thought best, as in hydro-nephrosis and similar conditions, and the kidney may be placed to the left of the body, to be removed with the rest of the genito-urinary organs, or the ureter may be cut off.

In order to remove the adrenal with the kidney it must be loosened from its bed by means of small incisions before the kidney is lifted out of the body; it is very friable as a rule and must be handled with care

The right kidney and adrenal are removed similarly. The small intestines are brought out of the abdomen to the left. The peritoneum along the outer surface of the cecum is incised and the meso-colon divided sufficiently to permit the cecum, the ascending colon and the hepatic flexure to be carried to the left, thus uncovering the kidney. The liver may be allowed to fall into the chest cavity by dividing the diaphragm and then the right adrenal becomes readily accessible as it lies in the shallow depression on the under surface of the liver, from which it must be dissected loose, care being used not to wound the closely adjacent vena cava. The right ureter can be isolated down to its entrance into the bladder.

In order to simply remove the kidneys an incision may be made or an opening torn behind the upper portions of the ascending and descending colon, through which the hand may enter and loosen the kidneys which are brought upward, the connections with the vessels and the ureters being separated, but this method does

not afford any opportunity to examine the organs with the adrenals, the vessels and the ureters all in situ.

In cases of acquired or congenital malposition of the kidneys it may be necessary to deviate considerably from the mode of procedure above detailed, because in the instance of floating kidney the great lengthening of the vessels and in the instance of the congenitally fixed dislocations, with or without fusion, the atypical origin and number of the vessels, may render a more extensive dissection necessary than can be done with the intestines still in the body. In fact, there can be no objection whatsoever to removing the intestines in the manner soon to be described before attempting any examination of the kidneys or adrenals; such an order of procedure could not but aid in the detection of changes and abnormalities in the renal as well as other vessels and in the ureters. In deference to old custom, however, which undoubtedly originated from the fact that in very many private and clinical cases no examination of the intestines is made, the method of securing a reasonably thorough investigation of the renal vessels and the ureters with the intestines in situ, has been detailed.

The adrenals are to be detached from the kidneys, weighed and measured. They are incised in the longest diameter through their flattened surface.

The fatty capsule of the kidneys should be removed before any incision is made; then they should be weighed and measured, and the shape noted.

The next step is to divide the kidney into two equal, longitudinal halves by an incision from the con-

vex margin to the pelvis. The kidney is held firmly in the left hand with the hilus in the angle between the thumb and the fingers, the thumb being applied to one surface and the fingers to the opposite aspect, and with one stroke of the long knife the division into equal halves is made from one end to the other and from the convex border as far as the hilus (Fig. 32). In this way the largest possible cut surface is exposed.

Fig. 32.—Incising the kidney.

To fully display the apices of the papillæ it will be necessary to cut open the pelvis and the calyces more extensively with scissors.

In order to detach the fibrous capsule of the kidney the cut margin is pinched up by the thumb and finger and stripped off from the surface. When the capsule is thickened and adherent as a consequence of chronic inflammation, then thin layers of cortical sub-

stance are brought away with it. The capsule must not be stripped off from those parts intended for histologic study.

After removal of the capsule the external surface can be examined with reference to color, to smoothness or granulation, depressions and furrows, cysts and dilated vessels.

Next the attention is to be directed to the cut surface of the kidney. The relative proportion of the cortical and the medullary parts is important to ascertain; in the normal kidney the thickness of the cortex compared to the medullary portion is as 1 to 3; the average width of the healthy cortex is 4 to 6 millimeters, but as the individual thickness may vary the relative size of the cortex to that of the medulla is much more important. This means the relative space occupied by cortex and medulla, the measurement being taken from the apex of a cone to the surface of the kidney which must be vertically divided as nearly in the median line as possible; the average of a few renculi must always be taken, obliquely cut cones being discarded. Any deviation in the normal proportional measurement of 1 to 3 requires investigation as to whether the cause of the disproportion lies in the cortex or in the medulla, as the cortex may be atrophied or increased in thickness, the medullary papillæ may be flattened or effaced.

The amount of blood in the kidney as a whole and the distribution of the blood to its various divisions must be noted.

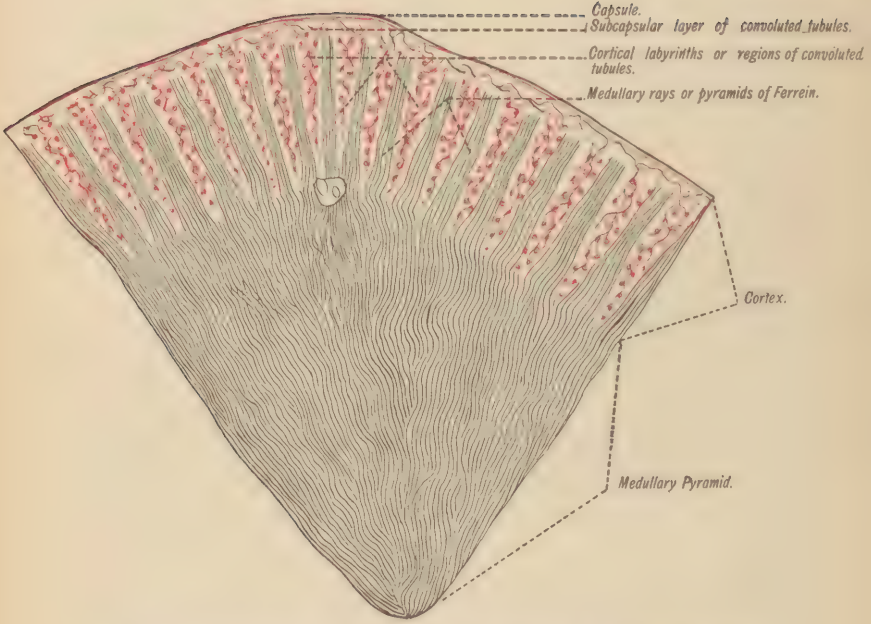

Fig. 33.—Diagrammatically exaggerated representation of the cut surface of a reneulus (medullary pyramid and corresponding cortical arch).

The cortical markings must be intently studied because modifications in their normal appearance are usually early present in the various inflammations and degenerations.

The so-called cortical markings are due to the alternating reddish and grayish striations of the renal cortex formed by the medullary rays which are composed of bundles of straight tubules of a clear, gray color, conical in shape, the apex terminating near the surface, and by the labyrinths which consist of the convoluted tubules, part of the loops of Henle, the glomeruli, and the vessels, the blood in which gives this portion a varying shade of red. The medullary rays are also sometimes referred to as the pyramids of Ferrein and the labyrinths are often spoken of as the regions of the convoluted tubules. The labyrinths show the most frequent alterations in color, because parenchymatous changes appear first in them, as well as on account of the dependence of the color upon the amount of blood present in the vessels and the glomeruli (Fig. 33). In advanced diffuse renal lesions the cortical markings become more or less altered and obliterated, the contrast between the medullary rays and labyrinths disappearing.

It is also of interest to bear in mind that normally the glomeruli are not found immediately underneath the surface of the kidney; when these bodies are superficial the kidney has atrophied.

While studying the cut kidney surface, note particularly the degree of distension and the condition of

the arteries as regards increased wall thickness as well as other changes.

Local lesions of various kinds are to be looked for in both cortex and medulla. The medullary region must be closely examined for the mechanical effects of excessive distension of the pelvis, for evidences of ascending changes, secondary to lesions in the lower urinary tract, and for the various forms of infarctions.

The mucous membrane of the pelvis and of its calyces has been laid open to full view by means of incisions with the scissors and the various anatomic changes likely to occur can be looked for, such as pyelitis, calculi, dilatation, and congenital anomalies.

The ureters, already examined externally before removing the kidneys from the body, may be incised with small scissors.

The examination of the kidneys may be recapitulated, as follows:

1. The kidneys and the ureters are exposed so fully while in situ that it can be determined whether or not the kidneys are to be removed separately or in conjunction with the other urinary and the genital organs. Sinultaneously the vessels may be isolated.

2. Remove the adrenals with the kidneys and examine separately.

3. Weigh and measure the kidneys after separating the fatty capsules.

4. Longitudinal incision from convex border to hilus, strip off fibrous capsule, and examine external surface.

5. Examine the section surface as regards relation of cortex to medulla, cortical markings, shape of papillæ, etc.

6. Medulla, pelvis, ureter.

THE PELVIC VISCERA.

These organs, including the bladder, urethra, the sexual apparatus and the rectum, should be removed together.

In case it is necessary to accurately examine the contents of the urinary bladder, this may be evacuated with a metal catheter in order to avoid loss or admixture with blood and other fluids; in the case of absence of, or obstruction to, the catheter the bladder may be evacuated by means of a longitudinal incision in its anterior surface.

The rectum must be separated from the descending colon between a double ligature so as to avoid fecal extravasation; the feces should always be pressed out of the intestine at the place of application of the ligature before this is tightened.

Then the bladder is to be drawn up away from the pubes and the fingers of the right hand, their volar surface toward the bladder, are insinuated behind the symphysis, the loose retro-peritoneal connective tissue is gradually separated from the inner pelvic wall so that the hand can be passed all around the pelvic organs and behind the rectum, great caution being used so as not to in any way unduly compress the tissues. In order to safely liberate the prostate completely, it is best to cut the fascia about the anterior aspect of the

gland close to its attachment to the under surface of the pubic arch. The pelvic viscera are now drawn firmly toward the diaphragm while the right hand divides with the knife the urethra, as far in front of the prostate as possible in men, the vagina at its middle in women, and the rectum as low down as possible. These viscera are now dragged out of the pelvis, the peritoneum is divided on all sides; the tubes and ovaries must be safely included and the large vessels behind the peritoneum must not be cut into.

In case it is necessary to include the urethra, the testicles, and the spermatic cords in men, or the external genitalia and entire vagina in women, this order of procedure has to be modified as follows: When it is desirable to preserve the attachment of the urethra to the bladder, the cutaneous covering is loosened from the penis and this organ is cut through more are less subcutaneously as far forward as necessary. The posterior attachments to the pubes, the ligamentum suspensorium and the lateral insertions of the corpora-cavernosa are cut across close to the bone and the penis can be drawn under the symphysis and removed with the other organs as already detailed. Unless the subpubic attachments are carefully severed the membranous portion of the urethra may be torn across.

The testicles, after carefully noting their position, if that be abnormal, can be removed from the scrotum by carefully enlarging the canals from the abdomen so that the glands will slip out quite easily when pressed upon from below; the vasa deferentia may be isolated

upon the sides of the pelvis down to the bladder, before any extensive separation of the pelvic viscera is attempted.

The female sexual organs together with the urethra, the vagina, the external parts, the rectum including the anus may be dissected out by detaching the pelvic viscera as before described; then the legs are widely separated and a cutaneous incision is made around the external genitalia, the perineum, and the anus; the separation is continued underneath the pubes and on the sides until the organs can be drawn backward underneath the pubes, and raised up as the separation is completed behind the lower end of the rectum.

It will be readily seen that if the kidneys have been loosened and the ureters isolated down to the bladder before the pelvic organs are enucleated, then the entire genito-urinary tract may be readily removed in toto together with the rectum and anus; in many cases of hydro- and pyo-nephrosis this procedure may be advisable and in extensive genito-urinary tuberculosis and ascending vesico-uretero-pyelo-nephritis a comprehensive view of the extent of the lesions is readily obtained in this way.

After their removal the pelvic organs are to be placed in their natural position, the rectum underneath and examined as far as possible from above downward.

Urethra and Bladder. In the male the corpora cavernosa are separated through the septum and an incision is carried along the urethra into the bladder; in the female the urethra may be divided in the same

way. In the male urethra strictures and false passages are especially to be looked for.

The bladder must be examined for hypertrophy, tuberculosis, inflammations, traumatic lesions, and tumors.

The Prostate. This is divided transversely in front of the oblong eminence on the floor of the prostatic urethra known as the caput gallinaginis or colliculus seminalis; further transverse cuts may be made if necessary. In this way the extent and location of evident hypertrophy, local tuberculous and suppurative foci and other lesions are exposed. It may be necessary to examine carefully the veins about this gland for evidences of thrombo-phlebitis.

The seminal vesicles lie between the rectum and the bladder upon the posterior wall of the latter above the prostate. In order to expose them the floor of the recto-vesical fossa is to be turned upward and the anterior wall of the rectum separated from the posterior wall of the bladder. The two vesicles will then be seen as rather long, flattened organs above the prostate and they can be incised longitudinally. The vas deferens on each side is easily seen at the same time and may be incised with a very fine pair of scissors.

The Testicles and the Spermatic Cord. After inspecting the exterior of the testicles and the epididymis, noting the size and consistency as well, a longitudinal incision is to be made through the testis, the body of Highmore and the epididymis with such separate cuts as may seem necessary to fully expose the parenchyma. The testis must be firmly grasped while

making this section, otherwise it may slip out from between the fingers.

The Vulva. The external genital organs in the female must be examined for lacerations, hematoma, inflammation, and neoplasms.

In medico-legal cases of suspected abortion or rape this examination becomes very important.

In the abortion cases punctures may be found in the external genitals, produced by the unskillful use of instruments, as well as the ordinary child-birth lacerations. Superficial and deep, irregularly distributed lacerations accompanied with swelling, discoloration and perhaps purulent inflammation suggest rape; especially would this be the case in children.

The Vagina. This canal may be incised on the left side up to the cervix uteri; then it may be separated from the anterior surface of the uterus, and in that way its entire extent is laid open for inspection; simultaneously the bladder may be dissected away from the uterus. What has already been said with reference to wounds and lacerations of the vulva applies to the vagina also.

The Uterus. This is first measured externally in its longest, broadest and thickest diameters, and variations in form as well as in position are carefully noted. Retracting perimetritic adhesions are to be considered with reference to their effect upon the position and shape of the uterus.

Before opening the uterus it is well to study the appearance of the external os which child-birth changes from a smooth, transverse slit to an irregularly shaped

orifice, the margins of which show recent or cicatrized tears. The uterus is incised along the middle of the anterior wall from the cervix to the fundus; from the upper end of and at right angles to this incision, two shorter ones are to be made, outward to each uterine opening of the Falloppian tubes. The thickness of the walls is to be measured and the relative size of the cervix compared to the body is to be estimated accurately. The size of the uterine vessels and the thickness of their walls are also to be noted. By means of these observations it will usually be possible to determine whether any previous pregnancy has occurred or not.

The color and consistency of the walls, the condition of the mucous membrane in regard to thickness and color are necessary observations.

The menstrual and the puerperal uterus may require differentiation, and for this purpose the examination of the ovaries in regard to the condition of the corpus luteum will be of much service.

In order to study closely the condition of the vessels, lymphatic as well as blood, in the puerperal uterus, incisions are to be made into the walls, especially at the placental attachment as well as elsewhere. Thrombophlebitis or lymphangitis may commence in cervical lacerations and these are consequently also to be incised so that the nature of the vascular contents can be positively made out.

The Broad Ligaments. The Falloppian tubes are to be examined as to size and shape. The fimbriæ are to be spread open and an attempt may be made to press

a little of the contents of the tubes out at the abdominal end. The tubes are to be slit open along their entire course. Dilatations, distortions due to adhesions, congenital twists and tortuosities demand careful investigation.

The position and the size of the ovaries as well as their shape are to be noted; the condition of the external surface, the color and the consistency are all points of importance. In order to expose section surfaces the ovaries are to be bisected by a longitudinal incision through the broadest plane. The color, the corpora fibrosa and lutea, possible cysts and abscesses, etc., can now be examined.

The vessels in the parametrium must be carefully examined. Thrombo-phlebitis and lymphangitis may occur secondary to similar processes in the uterus or vagina and may extend into the larger veins near by. Marantic thrombi are frequent in the uterine plexus and may give rise to sudden fatal pulmonary embolism; consequently these veins may have to be dissected out and incised with great care. In connection with this it is only necessary to mention that extra-uterine fetation must be borne in mind in all instances of intra-peritoneal hemorrhage in women, and that in the early stages it may be quite impossible to discover the embryo. It is also to be remembered that pus accumulations and tubal hemorrhages may result from extra-uterine pregnancy.

The Rectum. This part of the intestinal canal may be emptied of its fecal contents by means of a gentle stream of water allowed to run through it, and after that it is laid open with the enterotome along the

middle of the posterior wall, the pelvic viscera now lying with the bladder underneath. The mucous membrane and the walls can now be examined with all necessary minuteness of detail.

THE MESENTERY AND THE INTESTINES.

In the ordinary, routine post-mortem examination the intestines up to the duodenum should now be removed in order that as many as possible of the abdominal organs may have been taken out when it becomes necessary to examine into the patency of the bile passages, which involves opening the duodenum in situ and necessarily some extravasation of its contents. This order necessitates the examination of the mesentery at this time.

The Mesentery. The thickness, form, and length will be found to vary much. The mesenteric lymph apparatus is especially to be examined for enlargement of the glands and changes in the lacteals. Usually the ileo-cecal chain is earliest and most extensively involved, because the primary intestinal process (typhoid and tuberculosis) is most marked nearest the valve. Thrombosis may occur in the large mesenteric vessels secondary to stasis in the portal vein or to lesions in the intestinal mucous membrane.

Removal of Intestines. After external inspection of the bowels in situ, so as to have noted any unusual dilatation, change in color, alterations in the peritoneal coat, diverticula, etc., they may be removed in the following manner: Grasp the lower end of the large intestine which remains securely ligated from the time the rec-

tum was removed, make the intestine tense and then sever all attachments close to the bowel. When the small intestine is reached make the mesentery tense with the left hand, divide it as near the intestine as possible without injury to the latter by means of an almost continuous sawing motion of the knife, the edge of which is placed against the bowel (Fig. 34). In this way all the mesentery is cut away and this allows

Fig. 34.—Removal of the intestines.

the intestinal coils to straighten out completely. As the intestine is separated it may be allowed to fall between the thighs of the body or into a pail at its side. This detachment is continued as high up into the ascending duodenum as possible when a double ligature is applied, between which the division is made.

The contents may be washed out by drawing the upper extremity of the intestine over the faucet and

letting a stream of water run through from one end to the other. In special cases it may be advisable to examine separately the contents of the different regions. Both ends of such a portion may be ligated separately so as to avoid loss of the contents or admixture with other substances.

The further examination of the intestines may be postponed until the very last for obvious reasons of cleanliness; this is, of course, entirely a matter of choice. The small intestine is to be cut open along the mesenteric attachment, principally because Peyer's patches are situated opposite thereto and they may be the seat of very important lesions; this division is made by simply drawing the intestine through a partially opened enterotome, the blunt end of which is passed into the lumen of the bowel, and as this is continued the opened portion may be allowed to spread itself out over the fingers of the left hand (Fig. 35).

The large intestine is incised in the same way along one of the three longitudinal bands or tenia.

The intestine having been wholly opened, the contents may, if necessary, be washed off by holding the intestine under a stream of water. If this cannot be done, then the bowel may be drawn between two of the fingers of the left hand, and the portion cleansed in this manner allowed to fall into a pail of clean water; this process may be repeated as often as necessary.

In medico-legal cases it may be necessary to examine the contents of different portions of the intestinal tract separately in order to obtain information with reference to the length of time that intervened between

the taking of food and death, and perhaps in regard to other points as well. In that case the various parts may be separately ligated as indicated above.

The examination of intestinal contents includes observations upon their general characteristics, the quantity, color, consistency, and odor; parasites, indigestible food and various other abnormal ingredients must be looked for.

Fig. 35.—Opening the small intestine along the mesenteric border.

Any of the above or of the following remarks in regard to procedures that would result in obvious harm to the mucous lining are not applicable to those parts that are to be examined with the microscope.

Commencing with the upper end of the small intestine the entire mucosa and wall in general are now subjected to a minute, systematic examination. In the small intestine especial notice must be given the villi,

the valvulæ conniventes, the solitary and the agminate lymphatic structures. The thickness of the wall must be ascertained and the color of the mucosa noted; the thickening may be general, in all the coats, or it may involve only the mucosa and the submucosa when the normal folds become larger and longer than normal; folds may even form where they do not normally exist as in the lower ileum. Normally single villi can hardly be seen so as to be recognized with the naked eye; if the villi are much enlarged they may be detected as small, movable gray bodies.

The solitary and agminated follicles—Peyer's patches—are normally just capable of recognition; when easily and quickly seen they are enlarged. In the ileum the transverse folds in the mucous membrane suffer a more or less complete interruption at the site of the Peyer's patches, whose location can consequently readily be made out on this account even when not distinctly visible on account of morbid enlargement.

The aggregations of lymphoid structures are most extensive nearest the ileo-cecal valve, and the disease processes peculiar to the glands are as a rule most marked in this part of the intestine.

The vermiform appendage may be the seat of important old and recent lesions; its mucous membrane should be carefully inspected in all cases of peri-appendical fibrous adhesions for scars and ulcers; it may contain tubercular, typhoid, and catarrhal ulcers and the appendage demands careful examination in all cases of peritonitis.

In the large intestine the longitudinal muscular fibres are collected to form three flat bands which are about one-half shorter than the rest of the intestine, and thus "serve to produce the sacculi which are characteristic of the cecum and the colon." It is upon the projecting ridges thus formed that diphtheritic and other processes first appear. In the flexures the sacculi may be dilated and filled with hard fecal masses.

THE COMMON BILE DUCT AND THE PORTAL VEIN.

Before removing the stomach, the duodenum or the liver, the common bile duct, the portal vein and the hepatic artery must be examined as completely as possible while they are in situ, because the removal of those organs destroys the normal connections and relations.

After the external examination, the patency of the biliary passages may be tested in the following manner: The liver lies in the thorax, the gall bladder pointing upward. A small incision is made in the anterior wall of the second or transverse portion of the duodenum. The common bile duct and the pancreatic duct open separately or jointly upon the inner wall of the transverse part of the duodenum, a little below its middle, *i. e.*, about 9 *ctm.* below the pylorus; when the duodenum is stretched transversely the papilla will be seen just below the middle of the head of the pancreas. In order to determine whether the common bile duct is pervious, especially in the duodenal portion, the duct itself only is compressed between the fingers toward the papilla which is closely watched to see if the bile

is forced out. In catarrhal jaundice the occluding plug of desquamated epithelium may be minute and liable to be forced out unnoticed. Afterwards the gall bladder may be pressed upon in order to determine the condition of the whole length of the duct as to permeability.

The duct can now be probed from below and incised by means of scissors; in the case of extensive lesions the probing may be attempted from above through the hepatic duct. Simultaneous probing of the pancreatic duct may be undertaken.

The size of the duct is normally that of a goose-quill. The mucous membrane is normally colored with bile and if any obstruction has existed the portion below will be found free from biliary discoloration. Ulcers, perforations, strictures, cicatricial occlusions and various forms of inflammation may be found. Tumors and cicatricial contraction often render this examination troublesome.

The portal vein lies in the folds of the lesser omentum behind the common duct. After careful investigation of its surroundings and the exterior for evidences of chronic and acute inflammation, the vein may be slit open through its entire extent and its contents and structure can be examined. Malignant growths may perforate the walls of this vein; it may be the seat of a simple thrombosis due to various reasons and a portal thrombo-phlebitis may occur secondarily to the numerous forms of infectious lesions situated in the extensive territory drained by its branches.

The hepatic artery can also be slit open.

THE LIVER AND THE GALL BLADDER.

It is of course a matter of choice whether the liver and the gall bladder are removed before or after the stomach and the duodenum.

If the latter are to be incised fully in situ it would perhaps be best on account of reasons of cleanliness to remove the liver first.

If there are no contraindications in the shape of adhesions with neighboring organs, fistulæ, etc., then the liver may be taken out in the following manner: All the attachments of the right lobe are severed in the order in which they are met with as the liver is lifted up, such as the structures in the hepato-duodenal ligament; the left lobe is drawn over to the right and the tense attachments about it are divided, and lastly the broad ligament is severed. In case firm adhesions exist between the liver and the diaphragm, then the latter may be removed at the same time.

In cases of cirrhosis the ligamentum teres or round ligament may be examined for a persistent umbilical, or a para-umbilical, vein.

The liver is to be placed upon its anterior surface and the exterior and interior of the gall-bladder examined. After having noted any changes in the general appearance and in the serous coat the bladder may be opened by a longitudinal incision and the contents examined; the cystic duct should be slit open, in this way the presence of cholelithiasis and its consequences as well as other changes are readily seen. The bile ducts and the larger branches of the portal vein may

be still further slit up and the examination already made while they were in situ completed, as it were. The portal lymphatic glands are also to be investigated at this time.

The inferior vena cava, a portion of which is usually removed with the liver, may be laid open.

The liver is now placed upon its inferior surface and its dimensions taken: the transverse diameter of the whole organ and of the right and the left lobes separately, the antero-posterior diameter of these two lobes and also their thickness. Then the liver may be weighed.

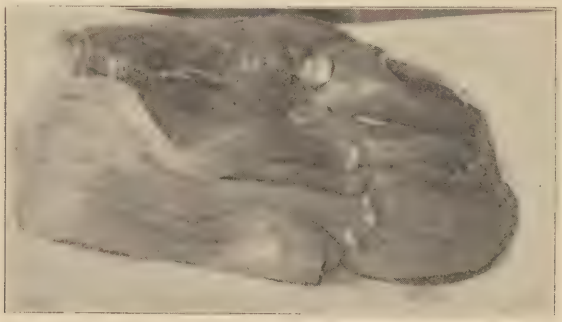

Fig. 36.—Section of the liver.
The liver has been divided into a number of transverse sections and a metastatic carcinomatous nodule cut across.

Variations in the usual shape, the general color, and the consistency and the condition of the capsule are now noted.

In order to expose the interior, long incisions passing transversely through the right and the left lobes at the same time may be made. The number of these incisions may be multiplied at pleasure, but they should be as nearly parallel as possible (Fig. 36).

The quantity of blood present in the hepatic vessels may be estimated by noting the amount that flows out upon the cut surfaces and that can be squeezed out of the parenchyma. The consistency and the smoothness or roughness of the cut surfaces are determined by palpation.

In order to distinguish between the two venous systems in the liver it is simply necessary to recollect that the portal branches are surrounded by the connective tissue of Glisson's capsule and accompanied by the bile ducts and the branches of the hepatic artery, whereas the hepatic veins occur singly, are very thin, and in direct apposition to the parenchyma in consequence of which fact they remain widely patent when cut across.

The description of the surface of a liver section is quite generally based upon the appearance presented by the transversely divided lobules, because nearly all the changes in the liver produce disturbances in the size, the shape, and the color of the lobules, and hence these must be examined with particular reference to any alterations. It is necessary to be able to recognize the individual lobules and also to be able to distinguish between their centre and periphery; it may be stated that if an hepatic vein be traced to its very commencement, this point will correspond to the centre of a lobule where the intralobular vein begins. As the blood after death mainly collects in the hepatic veins and adjacent capillaries it follows that the central portion of the lobule is oftener darker in color than the periphery; in the passive congestions of the liver this

central dark red color becomes very marked, while in fatty infiltration, for instance, the peripheral border of the lobules may be light grey or yellow.

THE STOMACH AND THE DUODENUM.

The general size, the position, and the shape of the stomach are easily made out while in situ.

Chronic adhesions about the gall bladder may involve or cover up the duodenum so as to require separation in order to bring its transverse and horizontal portions into view.

Perforation of the stomach or the duodenum and the effects thereof require a careful examination; when communications with adjacent organs have been established, it will be well to remove these organs with the stomach, departing from the usual method of taking out the organs to whatever extent may be necessary in order to preserve the specimen as intact as possible.

In post-mortem gastro-malacia and rupture the wall will present a softened, slimy appearance and a variable quantity of stomach contents will be found free in the peritoneal cavity in the vicinity of the rupture, without any inflammatory changes in the peritoneum, whereas perforation during life always results in local or general peritonitis.

It is true that the contents and the mucous membrane of the duodenum and the stomach can be fairly well examined without removing the organs by continuing the incision already made in the duodenum for the purpose of exposing the biliary orifice upward to the junction with the stomach; the diameter of the

pyloric opening may be estimated with the fingers or measured with the cone—and then the stomach is divided with the enterotome along the greater curvature up to the fundus so that the contents may be dipped out into a small cup, after which the division is continued into the esophagus; in this way the contents can certainly be closely enough inspected for ordinary purposes, but a careful study of the mucous lining demands the removal of the organs and nothing in particular is gained by opening them in situ when they are to be taken out. It would seem that the best way to proceed would be to remove them at once in the following manner:

Draw the lesser curvature downward and separate its attachments; dissect loose the lower end or as much of the esophagus as desired, dividing the diaphragm if necessary in order to free it fully, place a ligature around and cut it across if that has not already been done; then divide the structures along the greater curvature and dissect loose the duodenum, the lower end of which was ligated before removing the small intestine. In many instances of disease of the head of the pancreas resulting, perhaps, in its becoming matted together with the duodenum it may be very desirable to remove that organ at this time; otherwise the pancreatic and the bile ducts are cut across as they enter the wall of the descending duodenum.

The contents of the stomach may be collected by letting them flow into a cup or graduate after removing the ligature around the end of the esophagus or the duodenum; through small incisions in the greater

curvature the diameter of the cardiac and pyloric orifices may be measured with a cone and then an incision is made with an enterotome from the esophagus along the greater curvature and the whole length of the duodenum, removing any ligatures in advance; it is best to open the stomach along the greater curvature because peptic ulcers and other lesions are oftenest found in the vicinity of the lesser curve.

It may be well to wash away from the mucosa any adherent contents with a gentle stream of water; then the quantity as well as the nature of the mucus present, especially over the pyloric portion, may be noted; the numerous variations in color presented by the gastric mucosa must be accurately described and in the duodenum the extent of biliary discoloration must be noticed.

It is to be recollected that thickening of the gastric mucous membrane is to be determined by examining its line of junction with the esophageal; "Normally the lower, jagged edge of the esophageal mucous membrane projects over that of the stomach; when the latter is thickened this relation is changed, so that both either occupy the same level, or the gastric mucous membrane is the more prominent." Folds in the mucosa caused by contraction of the muscular coat disappear on stretching the walls in a vertical direction to the folds, while folds due to hypertrophy remain after such stretching.

Special morbid lesions, local or general, can now be looked for with all necessary attention to minute details.

THE PANCREAS.

The pancreas is now easily removed and after being weighed, measured and inspected a longitudinal incision may be made from head to tail, exposing the interior; usually the excretory duct is easily found on making this division and it may be further incised with small scissors.

Diseases in the region of the gall bladder, the duodenum, the pylorus and the pancreas often result in such matting together and adhesions that it may be necessary to remove these organs in conjunction in order to examine the complicated conditions satisfactorily. In removing such masses care is to be used so that the aorta and the vena cava are not damaged.

THE SEMILUNAR GANGLIA.

"The semilunar ganglia of the solar plexus, two in number, one on each side, are the largest ganglia in the body." They are situated on each side of the celiac axis and the superior mesenteric artery close to the suprarenal capsules in connection with which they may be removed. The ganglia lie upon the aorta just below and in front of the aortic opening in the diaphragm and whe they coalesce to form a ganglionic ring around the commencement of the celiac axis it is known as the solar or celiac ganglion.

In cases of Addison's disease and in other instances that render a thorough examination of these structures necessary the usual order may be changed to this extent, that the intestines, the liver, the stomach and the duodenum are removed while the adrenals, the

kidneys and the pancreas are left in situ until the sympathetic plexus and the semilunar ganglia have been isolated and removed (Nauwerck).

AORTA, VENA CAVA, THORACIC DUCT, RETROPERITONEAL GLANDS.

The mesentery is cut across at its root and then the aorta and what remains of the vena cava will be uncovered. The inferior vena cava and its large pelvic branches are slit open along the anterior wall and the contents as well as the walls examined; it is well to commence from above where the vena cava was cut across in removing the liver.

In case the thoracic duct is to be examined, this is easiest while the retroperitoneal organs are in situ and the aorta still intact. The duct lies behind and to the right of the aorta; it may be looked for at its commencement in the receptaculum chyli which lies upon the first or second lumbar vertebra, also to the right of and behind the aorta; at this point the right border of the aorta may be elevated and the duct dissected free from its beginning and upward, through the diaphragm, into the thorax clear up to its termination at the junction of the left internal jugular and subclavian veins. The duct may be slit open.

In many cases of acute general miliary tuberculosis as well as in cases of carcinoma in the abdomen the somewhat delicate dissection of this duct will certainly be necessary in order to obtain correct information as to the generalization of the processes mentioned.

The aorta and its terminal branches may be removed intact or incised and examined in situ. In order to remove it the upper end is seized and drawn forward, being separated at the same time from its attachments to the spine. The diameter of the vessel may be measured with cones previous to being opened; in adults it should admit the forefinger or the thumb.

The aorta and its large branches may present a number of important changes such as congenital hypoplasia, advanced as well as limited artero-sclerosis, aneurisms, thrombosis, etc; in the case of large aneurisms it may be necessary to remove the vessel in connection with other organs.

The retroperitoneal lymph glands are examined simultaneously with the aorta. The internal muscles of the trunk, the diaphragm and the ilio-psoas can also be investigated at this time.

The anterior surface of the spine and the pelvic bones may require examination on account of malformation, deformity or disease. Portions of the spine may be taken out and sawed through longitudinally and the entire pelvis may be removed from the body in the case of important pathological changes in the bones.

THE EXTREMITIES.

In the extremities the blood vessels, nerves, lymph glands and vessels, the muscles, the bones, and the joints may require examination in special cases; usually this examination is confined to those regions in which changes are known or suspected to exist.

The location and the course of the incisions employed for the purpose of exposing or isolating any of the structures just mentioned are in the main determined by the anatomic conditions; occasionally it may be necessary to conceal the cuts as much as possible. The nerves and the vessels are isolated in practically the same manner as a dissection is made; the larger structures are readily found in those parts of their course that bring them nearest the surface.

The size, color and consistency of the muscles, are readily noted; local and special morbid conditions demand careful consideration.

In opening the joints the familiar incisions used in ex-articulations and resection will answer very well; the condition of the capsule and of the ligaments is usually readily determined in that way; suspected perforations of the capsule must be cautiously explored. When the joint has been fully opened, the contents and synovial membrane as well as the articular ends of the bones, the size of the joint cavity, etc., can be studied with all requisite attention to detail.

In order to thoroughly and completely examine a bone it is necessary to remove it in toto or in part and divide it longitudinally or otherwise with a saw, so that the periosteum, the bone tissue proper, and the marrow may be studied. Alterations in the size, shape, color, and consistency of a bone demand detailed study; fractures and displacements require careful dissection.

In malignant tumors with metastases, in general miliary tuberculosis, in syphilis the osseous system is not infrequently involved; in such cases the examina-

tion of one long bone usually answers the purpose, and the bone most frequently selected is one of the femora, which can be removed from the body through an incision in the course of the large femoral vessels. The bone is placed in a vise and divided longitudinally by means of a saw in the direction of the neck; the sternum can also be readily sawed in two lengthwise.

In children that are presumably rachitic or suspected of syphilis the line of ossification at the various epiphyses may show very marked changes from the normal.

The bony marrow being so frequently the seat of morbid processes, it is necessary to bear in mind that it also varies in appearance in the young and old. In the young the marrow of all bones is red; after puberty the red color is retained in the flat bones only, while in the long bones it becomes yellow; under many circumstances a reversion to the red variety occurs in consequence of various pathologic changes.

EXAMINATION IN CASES OF SUSPECTED POISONING.

Cases of suspected poisoning demand separate consideration because they require a special method of examination on account of their medico-legal importance.

In order to preserve the organs and fluids from such cases in proper condition for chemical analysis a number of new, glass-stoppered jars and bottles, thoroughly washed, then rinsed with sulphuric acid and finally with distilled water, should be at hand. As the organs are placed in the jars, these should be sealed at once and labelled. If they can be delivered to the chemist immediately, then it is unnecessary to add any alcohol; if they are be kept for a time or sent quite a distance, then a sufficient quantity of strong alcohol is to be added. A quantity of the alcohol used is to be poured into a clean bottle, which is then sealed and labelled and sent with the organs; this is done in order that the chemical examination may show the alcohol to be free of poison.

While these organs remain in the hands of the physician he must keep them under sealed lock and key so that he can swear, if necessary, that no poison was added or the material in any way tampered with while they were under his care. Such jars should only be delivered to some properly authorized person, and an accurate record of the number, the contents,

the seal, and the disposition of the jars and bottles should be made on the spot and kept for future reference.

What organs and fluids should be preserved will depend largely on circumstances and upon what the particular poison suspected may be. The stomach, the intestines with contents, the liver, the brain, should always be preserved. In the case of diffusible poisons, strychnine, arsenic, etc., the urine should be drawn into a new, clean bottle with a clean catheter; and, in addition to the stomach and intestines with contents, every internal organ with a mass of muscular tissue and a large piece of bone should be kept for the purpose of furnishing the chemist with sufficient material to make the results of the analysis as positive as possible.

A portion of the blood should be kept in those cases in which spectrum analysis may be supposed to furnish important information.

The organs and tissues are subjected to the same general examination as under ordinary circumstances before they are placed in the jars, but much caution must be used not to bring them in contact with any possibly poisonous substances.

When poisoning is suspected the section commences with the abdominal cavity, the position and the fullness, color and smell of the stomach and other abdominal organs being carefully noted. Then a double ligature is placed around the lower end of the esophagus immediately above its junction with the stomach; the duodenum is tied in two places

in the same way, the ligatures being placed at a safe distance from each other so that they will not slip; then the stomach is removed, the duodenal ligature is cut and the end of the duodenum placed in a wide jar; by raising the cardiac end the stomach will empty itself into the jar.

In order to study the effects of corrosive poison the esophagus may be taken out with the stomach after having removed the other organs of the neck and placed a good ligature around the upper end; the contents can be emptied as before and then the incision opening the esophagus may be carried along the greater curvature out through the duodenum.

The small intestine may be removed, and the contents emptied into another jar or bottle and the large intestine can be treated likewise.

The examination of the digestive tract is done as early as possible in these cases in order that the contents may be preserved without admixture and in order to avoid the liability of injury to the stomach and the intestines that follows if they were to be examined in the usual order, so that everything can be placed at the disposal of the law under as favorable circumstances as possible.

On account of the likelihood that some of the contents of the stomach and intestines will cling to the mucous membrane after they are emptied, it is best to preserve these organs by themselves. With reference to the other organs it cannot be said to be *necessary* to preserve each single organ or set of organs by themselves, although that would be the best plan.

In case trichinosis is suspected the contents of the upper part of the small intestine must be subjected to careful microscopic examination and specimens are to be taken from the intercostal and cervical muscles and the diaphragm.

EXAMINATION OF NEW-BORN CHILDREN.

"In examining the bodies of new-born children we may have to determine, besides the ordinary lesions of disease, the age of the child, whether it was born alive, how long it has been dead, what was the cause of death."

The examination differs from the ordinary technique in the following respects:

I. *Inspection.* The external examination of the new-born involves a number of points which bear directly upon the age and the length of time that has elapsed since the birth of the child.

For a detailed description of the fetus during the different months of pregnancy reference is made to works on obstetrics.

The following table shows the weight and the length of the fetus at each month of gestation (v.Hecker cited by Nauwerck):

Second month....	Weight	4gr....	Length	2.5— 3 cm.
Third month.	"	5-20gr....	"	7— 9 cm.
Fourth month....	"	120gr....	"	10—17 cm.
Fifth month.	"	284gr....	"	18—27 cm.
Sixth month.	"	634gr....	"	28—34 cm.
Seventh month...	"	1218gr....	"	35—38 cm.
Eighth month....	"	1549gr....	"	39—41 cm.
Ninth month.....	"	1971gr....	"	42—44 cm.
Tenth month.....	"	2334gr....	"	45—47 cm.

From the fifth month the age in months can be determined by dividing the length in centimeters by five.

The pupillary membrane disappears in the eighth month.

At full term the skin is quite firm and white; the lanugo is found chiefly on the shoulders; the umbilicus is situated a little below the centre of the body; the cartilages in the nose and the ears are quite firm; the nails reach beyond the ends of the fingers but not beyond the ends of the toes; the labia are nearly always closed and both testicles should occupy the scrotum.

Fig. 37. –Centre of ossification in lower femoral epiphysis at term.

In addition to the length and the weight the following measurements may be taken (at term the results are about as given):

The length of the hair ..... 1.5— 3 cm.
The length of the anterior fontanelle ..... 2—2.5 cm.
The circumference of the head ..... 34—44 cm.
Mento-occipital diameter ..... 13—38 cm.
Fronto-occipital (longitudinal) diameter ..... 11—44 cm.

Transverse (parietal eminences) diameter..... 9—22 cm.
Bi-temporal (lower ends of coronal sutures) diam. 8—00 cm.
Width of the shoulders.....12—00 cm.
Width across trochanters..... 9—00 cm.

At this time it is most convenient to speak of one of the most reliable signs of maturity, namely, the ossification centre in the lower epiphysis of the femur, also known as Bèclard's centre. In order to demonstrate this centre the knee joint is opened by a horse-shoe

Fig. 38.—Beclard's centre at term.
The femur has been divided longitudinally.

shaped incision below the patella and then the cartilage of the femoral epiphysis is divided from below into thin transverse slices until the longest diameter of the focus of ossification present is reached; it is then measured. At term the diameter is from 2-5 *mm*; the centre is absent before the 37th week (Figs. 37 and 38).

After birth the skin becomes firmer; on the second or third day it assumes a yellowish tinge which

increases from the third to the fourth. The umbilical cord soon begins to shrivel, becomes brownish-red in color, and after three or four days the skin around its attachment becomes red; the end of the cord should be closely inspected to see whether it is cut or torn; a partially or wholly cicatrized navel, or redness, swelling and suppuration about the insertion of the still attached cord is a positive indication that the child has lived several days.

Finally, the whole body is looked over for marks of violence, blood, signs of decomposition, etc., and the mouth and nose are examined for foreign substances.

II. *The Spinal Canal.* In opening this canal the vertebral arches may be cut across with scissors. (Nauwerck.)

III. *The Head.* The incision and deflection of the soft parts is made exactly as in adults. The margins of the bones of the skull are then separated from their attachment to the dura in the following manner: make a small opening in the centre of the anterior fontanelle and incise the longitudinal inus with scissors throughout its whole extent; then divide the dura on each side of the sinus; cut through the dura with strong scissors along the coronal and lambdoidal sutures on each side, carefully avoiding the surface of the brain. The bones of the skull can be drawn away from the brain and cut through around the greatest circumference of the skull. The brain can now be removed as in the adult.

On account of the softness of the brain in children and the firmness of the adhesions between the dura and

the bones along the sutures it may be very difficult to succeed in removing the brain from a child without some injury. If it is not desired to preserve the brain as a whole, then Griesinger's method of sawing directly through the skull and the brain at the same time may be used to very good advantage; the skull cap receives the upper part of each hemisphere and the remainder of the brain is easily removed in the ordinary way (Fig 39).

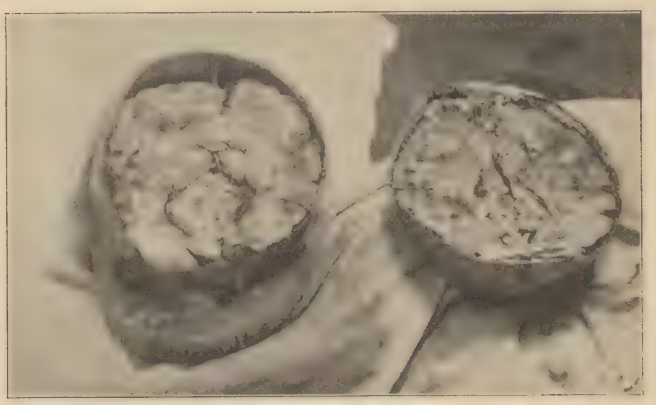

Fig. 39.—Griesinger's method of removing the brain. In this case the brain mass was very soft.

IV. *The Abdomen.* The umbilical vessels may be examined in the following manner: The usual incision is made from the chin downward in the median line; a short distance above the umbilicus this cut divides into two diverging incisions which extend to the pubes. The abdomen is opened in the lines thus mapped out and the triangular flap in the abdominal wall is raised

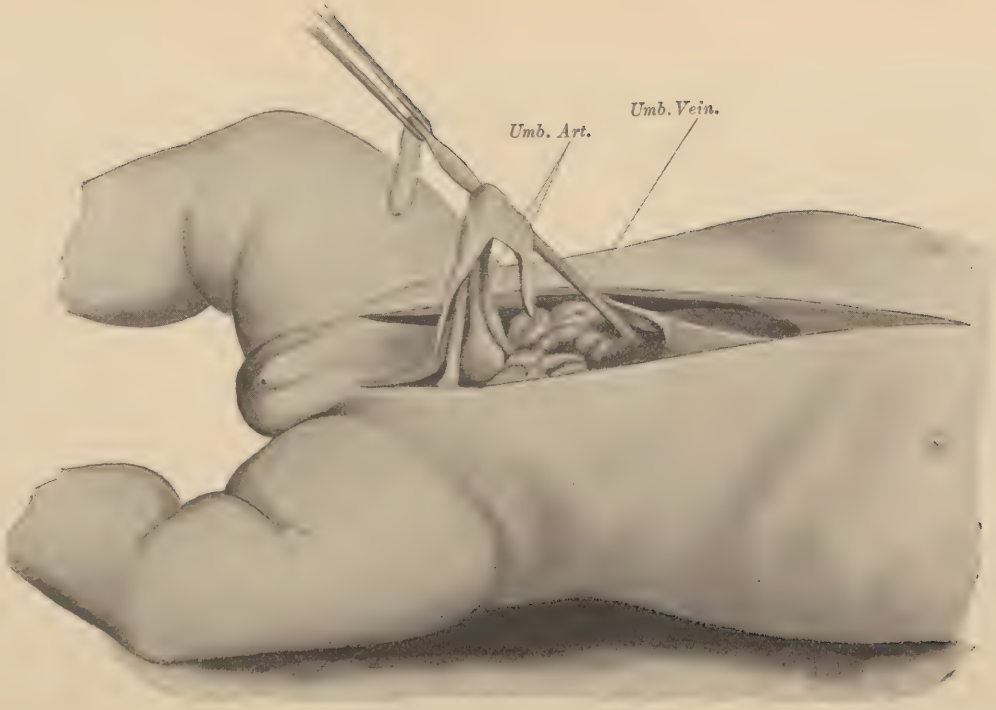

Fig. 40.—Examination of the umbilical vessels in newborn children (Nauwerck).

up by traction on the cord or at the navel. This brings the umbilical vein into prominence, its course to the liver can be followed and it may be opned with fine scissors: the vein can be ligated and divided, and the flap turned down over the pubes. The diverging umbilical arteries are now readily seen on each side of the remains of the urachus, and they can be opened with fine scissors also (Nauwerck) (Fig. 40).

V. *The Chest.* The ductus arteriosus is best examined while in situ. The thymus is first removed; then the right ventricle is incised along the septum and the incision extended into the pulmonary artery along the middle of its anterior wall. The orifice of the ductus arteriosus is situated between and beyond the two openings of the right and the left pulmonary branches; a small sound can be passed through the duct into the aorta, taking a direction downward and a little to the left.

The foramen ovale between the two auricles is readily found.

In order to determine whether respiration has taken place the following procedure is usually followed:

1. The condition of the diaphragm is determined before the chest is opened; when respiration has fully taken place the diaphragm reaches to the fifth or sixth rib, otherwise to the fourth only.

2. The trachea is to be ligated in the neck before opening the chest.

3. Open the chest cavity, examine the pleura, pericardium, and heart.

4. Open and examine pharynx, larynx and trachea above the ligature.

5. Remove the organs from the chest in toto, dividing the trachea above the ligature.

6. Separate the heart and the thymus gland and then place the lungs in a basin of clean, cold water and note whether they sink or float.

7. Incise the lungs, notice whether they crepitate or not, and whether air bubbles appear when portions are compressed below the surface of the water.

8. Divide the lungs into lobes and the lobes into small pieces and apply the hydrostatic test.

9. In the case of decomposition and the possible development in this way of sufficient gas in the lungs to buoy them up in the water, a number of small pieces from the lungs are to be placed between the folds of a towel, which is then thoroughly compressed between two flat surfaces, such as between a board and the floor by standing on the board. The gas due to decomposition is pressed out and the pieces from atelectatic but decomposed lungs will consequently sink when thrown in water after this treatment; inspired air, on the other hand, cannot be pressed out and the pieces from inflated lungs will continue to float.

It is to be borne in mind that the hydrostatic test only determines whether a child has or has not breathed.

The presence of gas in the digestive tract usually indicates extra-uterine deglutition. Portions of the digestive tract may be ligated and subjected to the hydrostatic test. Decomposition can cause the development of gas here also.

Average Weight of Organs at Full Term.

Brain	380	gr.
Heart	20.6	gr.
Liver	128	gr.
Lungs	55	gr.
Kidneys	23.5	gr.
Spleen	11	gr.
Thymus	14	gr.

RESTORATION OF THE BODY.

On completing the examination the body cavities should be sponged dry and the organs returned as near as possible to their respective places. The brain is usually placed in the thorax because it is rather difficult to force it all back into the cranial cavity, which had best be filled with absorbent cotton or sawdust and shavings (excelsior packing) or a sandbag so as to prevent bloody fluid from oozing out through the incisions.

In all private post-mortem examinations it is quite important to secure the skull-cap in its normal position so that the unsightly disfigurement, which results from its sliding backward and from side to side, may be avoided. Sutures through the divided temporal muscles and fasciæ on each side will generally hold the calvaria in place quite nicely if a good hold in the fasciæ is secured; sutures can also be passed through drill holes in the skull; double-ended tacks can also be used for this purpose; finally the plan advocated by Slee* may be mentioned: allow the usual saw-cuts to cross each other a little above and behind each ear so that slits about an inch long are formed in the temporal bones (Fig. 41); an ordinary roller bandage is now stretched across the skull and crowded edgewise into the slits; the calvaria is replaced and the extremities

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are brought over the vault and firmly secured by a knot or by pins.

After securing the skull-cap the scalp is sutured with the glover's stitch and the hair arranged so as to cover the incision.

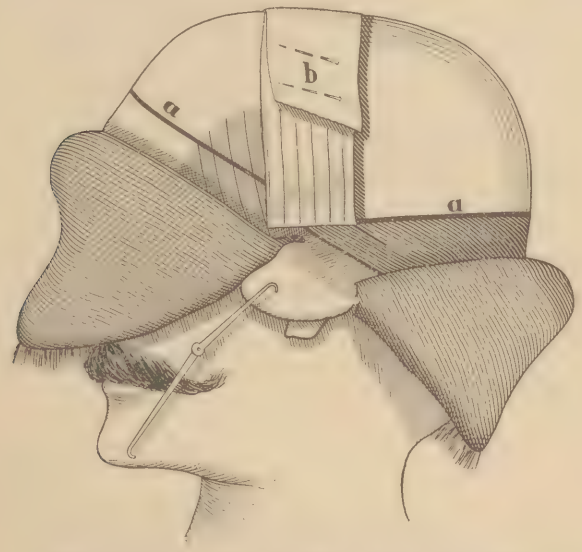

Fig. 41.—Slee's method of holding the calvaria in place. A. Margins of incision into the skull. B. Roller bandage stretches across vertex. (Slee.)

It may be advisable to fill the chest cavity with some packing material in order to restore the normal shape and fullness of the thorax before suturing the long anterior incision.

When the mouth has been forced open and the tongue removed with the organs of the neck, the lips may be united with a series of sutures passed through the oral mucous membrane.

The incisions at the pelvic outlet must be securely sutured; the pelvic cavity should be packed with cotton or similar material to prevent leakage.

In the place of bones that have been removed suitably formed pieces of wood may be inserted, and such pieces may be retained by means of wire or heavy cord passed through drill-holes.

The suture employed in closing cutaneous post-mortem incisions is inserted through the skin only, with a good sized curved needle, and each margin of the incision is perforated in turn from without inward so that the closure can be made quite tight after the manner of the glover's stitch; the ends of the thread (Barbour's linen thread No. 25) must be securely tied at the beginning and end of the suture.

Finally the exterior of the body is thoroughly cleansed.

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